

The Philippine Agriculturist and Forester

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EDITORIALS.

WITH this issue, the AGRICULTURIST AND FORESTER makes its first appearance as an official publication by the College of Agriculture instead of the organ of the student body alone. The change is one in form rather than in essence and is not expected to have any material effect on the matter published. There will be no change in editors, and the business manager will be Assistant Professor Gonzalez, who, while an undergraduate, was business manager of Volume I. The purpose of the change is to secure the service of the Government Bureau of Printing which was not practically available to the student body. At the same time that this change is made, the student body desires to express its appreciation of the excellent work which has been done for it by the previous printer, E. C. McCullough & Co.

The college has been induced to assume formal responsibility for the business side of the publication as well as for its editorial management by the demonstration made by the last business manager that a technical publication of this kind can be pub-

lished here without financial loss, or even real danger of such loss. In assuming responsibility, the college invites attention to this demonstration as one worthy of very respectful attention. There are not many parts of the world where the successful publication of a strictly technical agricultural journal by a body of students would not be regarded as a notably creditable achievement. If there be any other place where such a journal has held itself as strictly to its technical field, or can show a cash balance after as long a period of publication, this is not shown by our exchanges. The college believes that the record of its student body is in this respect unique.

AS ANNOUNCED in another column of this issue, Professor Edwin Bingham Copeland, retired under the Osmeña Act, thereby severing his official connection with the College of Agriculture as its dean and professor of plant physiology. With his departure the College suffers a loss that is practically beyond repair.

When, a little less than a decade ago, Professor Copeland set upon the task of establishing the present College of Agriculture, he ventured into an enterprise that previous to that time no man had ever attempted. The experiment was a novel one; and the conditions then existing promised everything but favorable results. But in carrying out his plan, Professor Copeland saw prospects that nobody else had seen; he had success easily within reach where another could only find discouragement. Fear, doubt, or uncertainty found no place in his thoughts, for with his natural broadmindedness and keen foresight he had carefully and conscientiously studied over his plan before he put it into practice. He had known beforehand that the realization of a Philippine college of agriculture was something more than merely a beautiful dream; and when he undertook to assume the responsibility of working for its formation, he had all the assurance of an encouraging outcome. And he was not mistaken. From a humble beginning, the college grew in size and importance year after year, mainly through his masterly guidance, until it has finally reached a standard which, in many respects, few institutions of its kind can at present surpass. During the few years of its existence it has turned out as graduates more than a hundred Filipino young men, who, from all indications, are bound to play an important part in the material, social, and political development of their country.

Writing from Singapore, Professor Charles Fuller Baker says of Professor Copeland's work as dean of this college:

He is a big man and a strong man, and men as good as he are exceedingly few

and far between. He has built the college in the face of great obstacles and difficulties, and yet has accomplished wonders there in a very few years. And he has had faith in the possibilities of Filipino young men as very few others have, and there have been fine examples of justification of that faith. He has also held the standards of the college high when there were all sorts of influences at work to pull them down. In other hands the college might now be a mere farm school, while as it is, the institution is moving in the direction of being a real college, a technical school for higher training in agriculture. It would be a tragedy for the Islands to lose any of the headway that has been gained through Dr. Copeland's long and strenuous efforts.

Like all other able administrators, Professor Copeland's most outstanding characteristics are his strict attention to business and his painstaking and careful study of all plans he intended to carry into execution. To the members of the faculty under him he was always kind and obliging, while at the same time he never lost sight of the fact that business always had to be handled in a business-like manner. To his students he was at all times gentlemanly and paternal; and although very often seemingly stern, hard, merciless, inconsiderate, and unsympathetic, yet it was obviously his disciplinary method and his means to build the character of the forming manhood to veil with external austerity the more generous and kinder soul within. He followed one main policy, and in this he succeeded: he aimed to impress upon the minds of the students, by actually making them practice it, the value of work—not merely work for the sake of working, but work which has a definite purpose in view, for without the latter it loses all its value and becomes a mere waste of energy and human power.

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EDWIN BINGHAM COPELAND.

Edwin Bingham Copeland was born at Monroe, Wisconsin, U. S. A., September 30, 1873. His father was a brilliant zoölogist, and his family, on both sides, has been in America since the revolutionary days. As a boy, Edwin was very active. While in the high school he began his work as a botanist and accumulated an extensive herbarium of the plants of central Wisconsin. At the age of 18 he entered the University of Wisconsin, where he did the first three years of undergraduate work. He was a brilliant student and was very active in various lines of student activities. He was captain of the track team in 1894 and was a western intercollegiate record holder in the half-mile.

In 1894 Leland Stanford Junior University was beginning to offer special advantages in scientific work, and Copeland went there for his senior year, taking the degree of A. B. in 1895. Following his graduation, he went to Germany to take special work in plant physiology and agriculture at Leipzig and Halle. This work led to the degree of Ph. D. in 1896 at Halle. In 1897-98 Dr. Copeland was assistant professor of botany at the University of Indiana, professor of botany at the State Normal School, Chico, California, in 1899, and at the University of West Virginia, 1899-1901; between 1896 and 1901 he found time to do some special work at the Universities of Wisconsin and Chicago and was professor of cryptogamic botany at the Cold Spring Harbor Station during the summer of 1901; 1901-1903, instructor at Stanford University; 1903-1908, systematic botanist in the Bureau of Science, Manila; 1908,

superintendent, School of Agriculture; 1909-1917, dean, College of Agriculture, University of the Philippines, Los Baños, Laguna.

He has accomplished a large amount of high-grade work in a surprisingly wide range of subjects.

Botany.—As a systematic botanist, he has specialized on the ferns and is recognized as one of the leading authorities on that group. He has published extensively on the ferns of the Philippine Islands and of the Malay Archipelago and New Guinea. In 1906 he published a key to the families of flowering plants and ferns in the Philippine Islands. This was issued in Bull. No. 24 of the Bureau of Education, with an outline of a year's course in botany.

Physiological Botany.—Dr. Copeland has made the work on this subject the basis for the more technical work in agriculture. He has published numerous articles dealing with his physiological work. Some of his work, of twenty years since, furnishes one of the best explanations of the ascent of sap in trees.

Agriculture.—Dr. Copeland has given the keenest of study to the problems of Philippine agriculture and is, doubtless, better informed than any one else as to Philippine agricultural conditions. He has placed great emphasis on the necessity for right principles in agricultural practice. He has had the viewpoint of the practical man as well as that of the scientist.

In 1907 he wrote an Elementary Textbook in Agriculture for the use of the public schools.

In 1914 his book on "The Coconut" was published. It will probably re-

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RESOLUTIONS OF GRATITUDE.

RESOLUTIONS ADOPTED BY THE STUDENT BODY OF THE COLLEGE OF AGRICULTURE AT LOS BAÑOS, LAGUNA, AUGUST 29, 1917.

Whereas Professor Edwin Bingham Copeland, after nearly a decade and a half of distinguished services in the Philippine Government, is soon to be retired, and, therefore, separated, probably permanently, from the people among whom he has spent many useful years of his life;

Whereas Professor Copeland, as the founder and first dean of the College of Agriculture, is largely responsible for the present high standards maintained in this institution and, both in his official capacity and as a private citizen, has contributed greatly to the advancement of scientific agriculture in the Philippine Islands;

Whereas as a teacher and administrator he has wielded a very great influence in molding the character of hundreds of Filipino young men, thereby making of them citizens who in the days to come will be more useful to their country; and

Whereas in the retirement of Professor Copeland the student body of the College of Agriculture, University of the Philippines, will lose an efficient teacher and true friend; therefore be it

Resolved, That the student body express, and does hereby express, its gratitude to its departing dean and its regret at losing him; be it further

Resolved, That in order to aid in perpetuating his memory among our people, a likeness of him in an appropriate size and form be placed in the office which he has used as head of this institution; and be it further

Resolved, That a copy of these resolutions be placed in the hands of Professor Copeland; that copies be furnished the secretary of the University of the Philippines and the office of the dean of this college with the request that they be filed; that a copy be spread upon the minutes of this meeting of the student body; and that they be published in THE PHILIPPINE AGRICULTURIST AND FORESTER.

For the Student Body of the College of Agriculture.

LEOPOLDO B. UICHANCO, *Chairman*,
SOTERO F. ALBANO, *Member*,
GERARDO O. OCFEMIA, *Member*,

The Committee on Resolutions.

Dated at the College of Agriculture, Los Baños, Laguna, this twenty-ninth day of August, nineteen hundred and seventeen.

RESOLUTIONS ADOPTED BY THE COLLEGE OF AGRICULTURE ALUMNI ASSOCIATION AT A SPECIAL MEETING HELD IN THE MANILA HOTEL ON AUGUST 11, 1917.

Whereas Professor Edwin Bingham Copeland, dean of the College of Agriculture, will retire from service in the Philippine Government, September 1, 1917; and

Whereas Professor Copeland has been in the Philippine service for over fourteen years and in these years has given his best efforts to promoting the interest or agricultural science and education in our country; and

Whereas the people of the Philippine Islands in general and we, the alumni of the College of Agriculture, in particular, owe Professor Copeland a debt of gratitude for his untiring zeal in building up an institution for higher education in agriculture in our country and in maintaining the standard of this institution as high as has been possible under existing conditions; and

Whereas by the retirement of Professor Copeland we lose a great and a beneficent teacher whose fine personality has always been a source of inspiration to us and greatly instrumental in the molding of our character; and

Whereas we believe that the results of Professor Copeland's efforts should not end with his retirement, but that they should forever remain an example of the noblest and most unselfish sacrifice of a man for the best training and education of our youth, and that they should be the source of inspiration to the classes that are to come; it is therefore

Resolved, That we, the members of the College of Agriculture Alumni Association, express our deepest regret at the loss of such a distinguished public servant and friend, and that we place in the College of Agriculture a bronze tablet with the following inscription:

TO EDWIN BINGHAM COPELAND, FOUNDER AND FIRST
DEAN OF THE COLLEGE OF AGRICULTURE.
DEDICATED IN RECOGNITION OF HIS SERVICES TO THE
CAUSE OF AGRICULTURAL SCIENCE AND EDUCATION IN
THE PHILIPPINE ISLANDS.
THE CLASSES OF
'11, '12, '13, '14, '15, '16, '17.

That these resolutions be signed by the members of the advisory board of the association, and that copies thereof be sent to Professor Copeland, to the Board of Regents, to the College of Agriculture, and to the press.

MANUEL L. ROXAS, *President*.

INOCENCIO ELAYDA, *Vice-President*.

JOSE J. MIRASOL, *Secretary*.

JOSE ZAMORA, *Treasurer*.

CURRENT LITERATURE.

The Agricultural Gazette of New South Wales, volume 28, page 498, for July, 1917, contains a very interesting and practical article entitled "The Cultivation of *Agave sisalina*," dealing with the cultivation of this crop in South Africa. The directions for cultivation are concise and at the same time as complete as general directions can be. If a single variety or species of *Agave* is in cultivation in South Africa, nothing more can be desired. However, this article, written in Zambesia, is for use in Australia; it might also be useful in the Philippines, if we could tell what plant is dealt with. It is well understood in the Philippines that the different species of cultivated *Agave* make somewhat different demands upon climate and soil, live and

produce for different lengths of time, and differ in the amount of fiber produced and the details of methods of extraction. *Agave sisalina* is not a known species. *Agave sisalina* Perrine is more or less cultivated in many countries, including German East Africa and the Philippines. This is evidently not the plant in question, because, in connection with harvesting, it is noted that the prickles on the edge of the leaves must be scraped off. A responsible botanical identification of the subject of this paper would multiply the value of the paper. Some people object to regarding agronomy as applied botany; but, for purposes of publication, applied botany is much more useful than agriculture without botany. (E. B. C.)

EDITORIALS.

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A mere display of adjectives in the superlative degree will fail to convey the idea of Professor Copeland's real worth such as can be learned by actual personal contact with him. It is needless to state how we feel his

loss; and, through the work he has done for the College of Agriculture, for the hundreds of Filipino young men that have had the fortune of being influenced by his teachings, and for the country at large, his name will not soon be forgotten.

EDWIN BINGHAM COPELAND.

(Continued from page 2.)

main the standard work on the subject for some time to come.

His courses in the College of Agriculture have been carefully and thoroughly taught. Each course has been worked out with a carefully prepared syllabus.

As dean of the Agricultural College, Dr. Copeland has combined, to a most unusual degree, the work of the administrator, the investigator, the teacher, and the understanding and sympathetic friend.

(F. W. F.)

A STUDY OF PHILIPPINE BAST FIBERS.

By NEMESIO BLANCO MENDIOLA.

[Graduation thesis, prepared in the College of Agriculture, No. 65; for the degree of Master of Science, No. 2.]

INTRODUCTION.

Published studies on the Philippine fibers have been almost wholly confined to fibers of the monocotyledones. Abaca, one of our principal exports and the most useful textile fiber of the Philippines, is of the monocotyledones, so that it was natural for early investigators to direct their attention to the monocotyledonous fibers. George F. Richmond says: "While a number of netted-veined fibrous plants, such as ramie and jute, are distinctly tropical inhabitat, only a few unimportant species are found in the Philippines." When men of science hold such a view, the lack of study of the Philippine bast fibers is not surprising. However, in these early days of Philippine science, and at a time when we seem to be on the verge of a great economic awakening, no field should be left untouched, not only when it promises to render substantial contribution to knowledge but, more important even, when it has some important bearing on some phase of the economic life of the country. The study of Philippine dicotyledonous fiber plants is one such field. In the last three years we have imported bags to the value of ₱691,506, which amounts to an average annual importation of ₱230,502. In 1913 we imported cordage to the value of ₱9,408(37). As a heavy increase in our rice production is at present being contemplated, there should be consideration also of the possible manufacture of the bags used as rice containers; and until we can show the manufacturer that the material needed is available for pro-

fitable manufacture, we cannot expect such an industry to be started. And how shall we account for our annual importation of cordage to the amount of several thousands of pesos, when the Philippines is the principal abaca producing and exporting country in the world? An explanation of this anomaly may be found in the fact that abaca is vastly superior in strength and value to the material of which the imported cordage is made, and, therefore, is too costly to be used in the manufacture of cheaper cordage. This economic problem, therefore, demands a search for fibrous materials which may serve as abaca substitutes and for economical methods of manufacturing them into the class of cordages that are now imported.

Fortunately, there is much to encourage and stimulate the investigator. Fiber plants growing wild abound in waste places and in fields not under cultivation. Some of these plants are of such a habit as to withstand drought to the same degree as the cogon grass does.

The following study has been carried through in so short a time that it does not pretend to cover the field to such an extent as to throw light on all the important phases of the subject, but it is hoped that it will furnish a beginning which may be useful to those who may desire to carry on further research in the same line of work.

PRESENT STATE OF BAST FIBER INDUSTRY IN THE PHILIPPINES.

The last census report indicates that home manufacture of cordage

from various materials is common all over the Philippines. This condition is natural as abaca is not widely grown in the Islands, and, besides, it is a valuable export, while available materials other than abaca are found everywhere and at all seasons. The varied industries of the people, from fishing to farming, and the various needs for cordage in domestic life demand its local manufacture.

The Filipinos have various ways of obtaining fibers from plants. The bark is either stripped from the plant without removing the epidermis, or else the latter is first taken off and then the fiber with its adherent materials is extracted from the tree. After removing as much of the non-fibrous part as possible, the fiber is dried and made ready for manufacture. Another method is to water-ret the fiber, either directly after its removal from the plant or after some preliminary treatment, such as allowing it to lie on the ground for a time, if the nature of the plant so requires.

Most of the bast fibers extracted in the Islands are used in making cords of different sizes. The method of cord making practiced is very simple. The fiber is first spun into yarn either by hand or by the use of what may be termed a hand rope-machine. This consists of a twirler, the hand furnishing the power. At the end of the twirler is fastened one end of the yarn and, as the twirler is revolved, the yarn is made longer and longer by continuously adding more and more fiber to the other end, which is handled by another man. The operator of the twirler usually possesses a high degree of skill in controlling the uniformity of twist and the diameter of the yarn.

The yarns are made into cords of

two or three strands, either by hand or by a machine. Cords of three strands are very common. To make these, six or four twirlers are used, half being used at each end. To each of the opposite sets of two or three twirlers is fastened a yarn. The twirlers in each set are turned with a common handle, thus causing them to make about the same number of revolutions per minute, which simultaneously twist the two or three yarns. Each set of twirlers is in a frame mounted on a movable support something like a sled; these are drawn nearer to one another as the length of the yarn decreases. After twisting them to the desired degree, the two or three ends are fastened to one twirler where the formation of the cord begins. This is done with the help of a reel.

Samples of fibers obtained in this work were taken to the rope factory of the Johnson-Picket Rope Company, located in Manila, in the district of San Nicolas, to find out if the company would accept an order for ropes made of the bast fibers. The company refused, on the ground that the fibers would not pass through the machine which is adapted to maguey and hemp.

The cords are mostly used in the localities where they are made. A small amount only is sold in the market. In Los Baños and neighboring towns cord made of fibers of *Melochia umbellata* (Labayo) is commonly sold in the markets at an average price of 20 centavos per kilo, while abaca cord sells for 80 centavos a kilo.

MATERIALS STUDIED.

Thirteen species of six families have been covered in this study. They are:

STERCULIACEÆ.

<i>Abroma augusta</i>	<i>Anabo</i>
<i>Kleinhofia hospita</i>	<i>Tanag</i>
<i>Melochia umbellata</i>	<i>Labayo</i>

MALVACEÆ.

<i>Urena lobata</i>	<i>Culutculutan</i>
<i>Hibiscus sabdariffa</i>	<i>Roselle</i>
<i>Malachra fasciata</i>	<i>Sipit-ulang</i>
<i>Malachra capitata</i>	<i>Paang-baliuis</i>

TILIACEÆ.

<i>Triumfetta bartramia</i>	<i>Culutculutan</i>
<i>Grewia multiflora</i>	<i>Danling</i>
<i>Columbia serratifolia</i>	<i>Anilao</i>

URTICACEÆ.

<i>Pipturus arborescens</i>	<i>Dalunot</i>
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LEGUMINOSEÆ.

<i>Sesbania grandiflora</i>	<i>Caturay</i>
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THYMELEACEÆ.

<i>Wikstroemia ovada</i>	
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REMARKS ON BOTANICAL STUDY.

Botanical descriptions of the plants are mostly from Merrill's Flora of Manila. Distribution and names of each plant in different dialects have been obtained from the 1903 census of the Philippines, and from information given by students in this college.

Cross sections for microscopic study were made by the use of a sliding microtome. Care was taken to get sections from twigs of the same diameter. Individual fibers were obtained by placing a fragment of the bark in a solution of potassium chlorate and nitric acid and beating until the bark was softened. It was then washed in water, freed of the solution, and separated with dissecting needles. Concentrated nitric acid is provided for in the standard macerating solution, but the writer found the use of dilute acid more convenient in that it avoid danger of over-treatment.

Sections for permanent mounts were stained with Bismark Brown,

washed in alcohol and mounted in Canada balsam dissolved in toluol, after clearing them in the latter reagent.

Microscopic drawings were made with the help of a Camera Lucida, magnifying the objects 655 diameters. From each plant, except in two cases, 100 ultimates sampled from 10 different parts were measured as to their dimensions and as to the dimensions of their parts. Cell measurements were made as follows: The magnifying power of the combination used was first determined, then with the help of the Camera Lucida, whose bar and mirror are laid at a constant distance and angle respectively, the magnified dimensions of each ultimate fiber are reflected onto paper and measured, and finally these are reduced to absolute dimensions by dividing by the number of times the objects were magnified.

Fiber was extracted by retting the material in water.

There being no suitable machine available for cord manufacture, all cords used in the experimental part of this work were made by hand.

SEPARATE STUDIES OF INDIVIDUAL PLANTS.

STERCULIACEÆ.

ABROMA AUGUSTA Linn.

Abroma augusta is the perennial Indian hemp, or Devil's Cotton, and is known in India as *Ulat kambal*, *woolet-comul* or *Ullat-kumol*, *Olak tambol*, and *samu-kapashi*(16). Royle(1) states that it is a native of various parts of India, growing luxuriantly in gardens as far as 30 degrees north latitude, and extending eastward to the Philippines. In the latter country, it is called *anabo* by

the Tagalogs; *anabu* by Pampangans; *anafu* by the Ilocanos; and *sayapo* by the Visayans⁽²³⁾. Muller⁽³²⁾ states that it has been reported from Abra, Batangas, Capiz, Mindanao, Nueva Ecija, Occidental Negros, Pampanga, Nueva Vizcaya, Bohol, Oriental Negros, Ilocos Norte, Ilocos Sur, Tarlac, Sorsogon, and Cagayan.

Anabo is a perennial shrub which grows to at least 3 meters in height. The bark of the stem has hairs when young and spines also when old. The leaves and petioles have fine, sharp, prickly hairs. The lower surface of the leaves has a lighter color than the upper. The fruit is a fair-sized capsule which opens on top, and has five horn-like extensions on the outer free surface; five very much smaller projections make the attachment of the seeds to the inner surface. In the mature capsule, in the inside near the seeds are bristle-like hairs and on the outside the same kind of hairs occur as on the leaves.

Although this plant grows to be a small tree, it may be cultivated as an annual. In India it flowers profusely during the cold season.

Abroma augusta is usually propagated by seeds, but in India, and in this work, it has been found that it may also be propagated by cuttings. Among cuttings of different parts of the plant made and planted on May 24, 1915, those from primary branches calloused. On November 17 the sprouts averaged 35 centimeters high. Gamble states that *Abroma augusta* requires rich land and plenty of moisture⁽¹⁶⁾. On the other hand, Ranger Ferraris of the Philippine Bureau of Forestry⁽³⁶⁾ believes it will grow under less favorable conditions and thrives best in sandy soil along banks. Writing of this plant

in the Sarangani Bay district, he says: "This plant is a troublesome weed and will grow under any unfavorable conditions. After germination is started, this plant will grow, struggle with the other weeds and survive even during the dry season. What you have to care for is only to leave enough seed plants for the next year or to leave some of the plants to bear fruit before you cut them. If you have enough seeds on the ground when the rainy season comes, you will surely have a *sayapo* (*A. augusta*) plantation, for they will begin to grow as soon as rain comes."

In the Arboretum at the Forestry School and on the farm of the College of Agriculture there were some wild plants growing. The first receipt of seeds of this plant by the college was from Vilmorin Andrieux & Co. on March 13, 1911. On May 12 a part of the seeds was planted in flats and germinated on May 17, with the very low percentage of germination of 4. Ferraris collected from the Sarangani Bay district, along Sapan River, *anabo* seeds on October 2, 1914, which were received at the forestry station twenty days after. One liter of the seeds was found to weigh 400 grams and to contain 46,000 seeds. On October 23, 1914, 2,760 seeds were planted in the forestry nursery bed where they germinated eight days after with 20.5 per cent germination. On January 1 of the following year there were living in the bed 855 plants about 7 centimeters in height. These were transplanted to nursery rows on January 6. On May 15 the seedlings were placed in bamboo pots and removed to the college nursery. Finally they were transplanted to the field northeast of the acclimatization plots,

formerly occupied by an old orchard. There they were spaced 4 by 4 meters apart. When 1 year old the height of the plants was 2.1 meters. The diameter of the bases averaged 4.4 centimeters. It must be remarked that eight days before they attained the age of 1 year they were blown down by storm, but were set up again.

Anabo is not only a fiber plant, but may be recommended, it is believed, for reforestation purposes. It grows on the *parang* and *cogon* areas and can check the growth of the grass after about one year without any care.

MICROSCOPIC STUDY.

(See Plate I, fig. 1.)

Cross sections were made from a twig 2.5 decimeters long, where the diameter was 0.75 centimeter. The plant bearing the twig was 5.25 meters high. Plate VI shows some groups of bast cells and cells surrounding them. The former are polygonal in shape, varying from triangular to 7-sided; 5- and 6-sided cells are the most common. In some cells the corners are more or less rounded. In total diameter the cells vary from 0.006 to 0.039 millimeter. The average diameter is 0.017 millimeter. The cell walls are commonly 0.003 to 0.007 millimeter thick, but one of the smallest cells examined had a wall only 0.001 millimeter in thickness. Although the diameter of the lumen is 0.005 millimeter on the average, it varies from 0.002 to 0.011 millimeter. The ultimate cells are 1.360 to 4.240 millimeters long, the average length being 2.213 millimeters. (See Tables VII (a) and VIII (a)). Longitudinally, the ultimate cells appear as thread-like structures, pointed at both ends. The ends taper

very gradually. Observations and measurements show that the lumens appear almost interrupted at several points in the cells.

The bast cells are in the layer of the bark appearing in compact masses. However, in a section from an older twig, there were several instances of intercellular spaces. The masses of bast cells are in three or four concentric layers, separated from one another and surrounded by parenchyma cells which interrupt the layers at different places. In the section examined the first layer is about 10 cells deep, while the rest are only 2 to 5 cells deep.

The cell walls are homogeneous. No pits were found. Bismarck Brown colored the cells brown, while a solution of picroacetic acid colored them yellow.

THE FIBER.

In the district of Sarangani Bay, at Sitio Sapu, Cotobato district, the fibers of *Abroma augusta* are extracted. The natives first cut the trees and then allow them to remain on the ground for the leaves and bristles to fall off. This process requires about two days, after which time the bark is stripped from the trunk and placed in water to cause the decay of the epidermis and the pulp. This takes four to six days. The fibers are then washed and freed from the adhering materials, dried, and made into bundles ready for sale. In this study the same method was used in obtaining fibers. It took two days (from July 24 to July 26) for leaves and bristles to fall off, and eight days (from July 27 to August 3) to ret in running water. In other instances four to eleven days were necessary for maceration. The dried product appears white and fairly

silky. Royle, writing on this phase of the subject, states: "To separate the bark from the shoots, maceration in stagnant water from four to eight days answers well during the warmer parts of the year, while three times as much is scarcely sufficient during the cold seasons, indeed the process is scarcely practicable then; besides, the fibers are greatly weakened by prolonged maceration."

Regarding possible yield the same author writes: "It (*Abroma augusta*) particularly attracted Dr. Roxburgh's attention, as the bark abounds with strong white fiber, which makes a very good substitute for hemp, affording good common cordage. The plant grows so quickly as to yield two, three, or even four crops of cuttings annually (4 to 8 feet long) fit for peeling; hence it may be advantageously cultivated, and is deserving of more than common attention on account of the beauty, fineness, and strength of its fibers. Dr. Roxburgh ventured to prognosticate as large a yearly produce as can be obtained from an acre of danchee, jute, sunn, hemp, or flax, as it is a perennial, large, shrubby plant, in every respect easier to cultivate and to prepare the fibers than sunn, and the produce much greater. Indeed, in an experimental culture he obtained from the cuttings 271 pounds of clean fiber, which he states was three times greater than the average produce of the sunn."

From the plants grown at this college, 4 meters each way, it was found that plants about a year old produced an average of 46 grams of clean dry fiber per plant. A flowering plant, however, yielded 57 grams of fiber. Using the former figures, a hectare of the plantation can produce 29 kilos

of fiber. A crop of cowpeas was grown successfully as an intercrop before the *anabo* attained the age of 1 year. Were the plants planted in quincunx, 1 hectare of land could have produced 32 kilos of fiber. An observation of the radius of the crowns of the plants would indicate that they could be planted very much closer together, as close probably as 2 meters apart. Were this done, 1 hectare could produce 115 kilos of fiber which, according to market price at Sarangani Bay district (₱8 a picul), will sell for ₱15.28.

Without being dressed in any way, the fiber of *Abroma augusta* is claimed to be about one-tenth stronger than sunn, and in that state much more durable in water. A cord of its fibers bore 74 pounds when sunn broke with 68 pounds.

Anabo fiber is used in the Islands for making ropes, twines, fishing lines, pouches, etc. (27).

KLEINHOFIA HOSPITA L.

This plant has been reported in the Philippines from Albay, Batangas, Bulacan, Capiz, Iloilo, Laguna, Nueva Ecija, Sorsogon, and Tarlac, where the Tagalogs and Visayans call it *tanag*; from Nueva Vizcaya, where the Gaddanes call it "bafé ñga bun-sing"; from Zambales, where it is called *biknong* by the Zambals; from Abra, Camarines, and Ilocos Norte, where it is called *bitnong*; and from Pampanga, where it is called *panampat* or *pampar*. It is also found in Eastern Africa, tropical Asia, and from Formosa southward to Malaya.

Tanag is a tree 8 to 15 meters high, somewhat pubescent or nearly glabrous. Leaves broadly ovate, acuminate, base 5- or 7-nerved cordate or truncate, 10 to 20 centimeters long,

long-petioled. Panicles ample, 20 to 40 centimeters long. Flowers pink, about 6 millimeters long, the sepals longer than the petals. Capsules about 2 centimeters long. According to Merrill, it flowers from September to November; at this college it flowers as early as June and throughout July, August, September, and November.

We have in the college grounds two sets of tanag trees, both sets having been grown from imported seeds. The first set was grown from seeds received from the Empress Botanical Garden, Poona. They are, at the present writing, 5 to 8 meters high and about 4 years old. Two of these were blown down by the recent baguio. They were pollarded, and the materials obtained when retted gave 500 grams of fiber. The other set was grown from seeds received from Lawang, Java. In both cases germination required six to eight days. Although *Kleinhofia hospita* is a tree, it may be made to produce at least two crops of shoots, nearly 1 meter long, a year. The plants from the second set in the two pollardings made produced from 15 to 23 shoots each.

Attempts to propagate this plant by cuttings have so far failed.

As regards enemies, it was observed that our plants at the college had their leaves attacked by *Cercospora kleinhofia*. The disease is not serious.

MICROSCOPIC STUDY.

(See Plate I, fig. 2.)

The cross section examined was taken from the middle of a twig, 2.5 decimeters long, at a point 0.75 centimeter in diameter.

The cells appeared to be polygonal in shape, as in the case of *Abroma augusta*, varying from those of 3 sides to those of 7 sides. The most com-

mon shapes are pentagonal and hexagonal. In total diameter the cells vary from 0.008 to 0.031 millimeter. The average is 0.018 millimeter. The thickness of the walls and the diameter of the lumen are also variable, but average 0.008 and 0.004 millimeter, respectively. The ultimate cells are 0.933 to 2.400 millimeters long, averaging 1.518 millimeters. They appear as slender thread-like structures with pointed ends. The typical end is one which tapers gradually. Some cells have extremely tapering ends. Although the shape longitudinally is regular, some fiber cells were found to be ridged on both sides. This is likewise true with the lumens; in a single cell it may be found to be very wide, and then narrowing gradually until at several points it is almost interrupted.

The bast cells, which are found in the inner layer of the bark, appear in compact masses. Only in very few instances were there found intercellular spaces. The groups of cells are in four circular layers, surrounded and separated from one another by parenchyma cells. The parenchyma cells which separate the bast groups radially are themselves in pyramidal or narrow rectangular groups, the pyramids pointing toward the center of the section. There are, in the sections examined, 31 to 35 of these separate groups.

The outermost layer is the thickest of the four and, on an average, 12 cells deep. There are places in the layer, however, that are only 2 cells deep, while at others the thickness reaches 20 cells. In a bast group there are about 45 bast cells. The other layers, on an average, 4 cells deep. The groups here are smaller, there being only about 8 cells in a

group. The last two layers are the closest together. The last layer is separated from the wood by the cambium, on which it abuts at several places. The cell walls are homogeneous.

THE FIBER.

Extraction of fibers, which is by retting in water, was begun in August. It took, in that month, eleven days to ret, from August 8 to August 14. The fiber obtained in August was white, but not as white as that of *Abroma augusta*. It was also fairly silky and gave the impression of being inferior to the fiber of anabo.

In this work it was found that it took 40 shoots 1.3 meters long to produce 78 grams of dry fiber. As the plants can produce at least two crops of shoots a year, about 1 meter long, at the rate of 19 shoots per plant, the latter can in a year produce at least 74 grams of fiber. At this college the *tanag* trees are growing at a distance of 4 meters each way, but on a field scale there is no reason why they cannot be planted to produce at least the same number of shoots per plant. Assuming that the plants are placed 2 meters each way, square method, a hectare of *tanag* trees can produce in a year at least 165 kilos of fiber.

In Port Glan, Sarangani Bay, the fibers of *tanag* are used by the natives in adulterating the fiber of *Abroma augusta*. They are also used for making ropes, twines, and cigar cases.

In Davao *tanag* trees are used as shade trees for abaca.

MELOCHIA UMBELLATA (Houtt.)
Merr.

This species is called *Melochia arborea* by Blanco and *Melochia indica* by A. Gray.

In Tagalog it is called *labayo*, while it is *balitnong* in the Visayas. According to Dr. F. W. Foxworthy, it is a small and apparently short-lived tree, very widely distributed in the *parang*, and has been one of the most common trees on the college farm. The native farmers in this locality say that wherever a *caingin* has been made and then neglected a thick growth of *labayo* soon covers the ground, but disappears in time to give way for bigger trees. Before the Maquiling Reserve was established, *labayo* and also *anilao* (*Columbia serratifolia*) were so common that at one spot two persons could, in less than a day, gather more fiber than a carabao can pull. For this reason *labayo* was for a long time a favorite fiber plant among the inhabitants of Los Baños and neighboring towns. Since the reserve was made *labayo* has been gradually disappearing.

MICROSCOPIC STUDY.

(See Plate I, fig. 3.)

The bast cells are polygonal, ranging from three-sided to seven-sided. Pentagonal cells are very common, while those of seven sides are very rare. With few exceptions, the cells are in compact masses, occurring as the inner layer of the bark. Few intercellular spaces were found in the section examined. The bast groups are in layers which vary in number from 1 to 3, 2 being the most frequent group. In this plant the pyramical grouping is not very evident. The bast-strands are surrounded by parenchyma cells and are separated from the wood by the cambium, on which some of the youngest bast groups about. The ultimate cells are 1.107 to 3.147 millimeters long and 0.011 to 0.027 millimeter broad. The cell walls, which are homogeneous,

vary in thickness from 0.004 to 0.007 millimeter. The lumens appear as dark spots and are 0.003 to 0.012 millimeter in diameter.

THE FIBER.

The fibers were obtained from trees growing in the second-growth forest in the Maquiling Reserve, and in strips about 1.5 to 2.5 meters long, 1.5 millimeters thick, and 2 to 8 centimeters broad. When fresh, the fiber is yellowish, but it becomes slightly brownish as it gets older. As the natives use it, it is made into cords after separation into small strips without previous retting.

MALVACEÆ.

URENA LOBATA L.

This plant is found in waste places throughout the Philippines, where it is said to be an introduced species. The Tagalogs call it *culut-culutan*, *colot-colotan*; the Visayans, with these names, also use *dalupan*; the Pampangans use the same names as the Tagalogs.

Urena lobata is "an erect, branched, shrubby plant, 0.6 to 2.5 m. high, exceedingly variable, more or less pubescent. Leaves pale beneath, ovate to suborbicular, 3 to 9 cm. long, cordate, more or less toothed, or lobed or angled, the lobes not cut beyond the middle of the leaf, the sinuses usually broad, acute. Flowers axillary, solitary or somewhat fascicled, pink, about 1.7 mm. in diameter. Fruit depressed-globose, about 7 mm. in diameter, the five carpels covered with short, retrose barbed spines. It flowers all the year." (29)

Another species of *Urena*, which grows side by side with *U. lobata*, is *U. sinuata*. The latter differs botanically from the former in that

the lobes of the leaves or the sinuses extend beyond the middle of the leaf. It grows also in Asia and South America.

Urena lobata, like the *cogon*, is not killed by drought, even in exposed places. Just how well it can withstand drought and overcome other weeds may be shown by a count made of the number of plants in a space of ground near the college farm after the last summer season. In a space about 30 by 30 meters there were 336 plants 1 to 2 meters high. In most parts of the field the crowns of the plants touched one another, thus leaving no chance for other weeds, except small vines, to survive among them. Although the plant is generally recognized as branchy, a type has been found that is well adapted for fiber extraction, for the reason that it is not very branchy and has long, erect stems with very small branches.

The plant propagates by seeds, but it may also be propagated by cuttings as shown by the results obtained in this work. It took four days for the cuttings to produce sprouts, which averaged 91 centimeters in height at the age of one-half year. It responded to pollarding, but the shoots grew so slowly that this behavior can be of no practical value.

MICROSCOPIC STUDY.

(See Plate II, fig. 1.)

The bast cells of *Urena lobata* are polygonal in shape, varying from those of 3 sides to those of 7. The most common shape is that of a pentagon. Some cells have irregular sides, but this form is rare. The size is fairly uniform. In the lumens there is little variation in the diameter, and the thickness of the walls varies only from 0.003 to 0.011 millimeter. The average is 0.007 milli-

meter. In total diameter the cells vary from 0.009 to 0.027 millimeter, with an average of 0.013 millimeter. The diameter of the lumens is 0.002 to 0.005 millimeter broad, with an average of 0.003 millimeter. The cells are 0.973 to 2.547 millimeters long. The average length is 1.442 millimeters.

In the section examined, the bast cells are in 55 pyramidal groups which point toward the outside and with bases near the wood. Each group is divided into vertical layers, varying in number in the different groups from 2 to 7, mostly 5. The layers and groups are separated from one another by parenchyma cells, also in shape of pyramids, but pointing toward the center of the section. The bast cells are separated from the wood by the cambium layer, on which they abut at different places. The bast cells appeared to be in compact masses and exist throughout the thickness of the bark. The cell walls are homogeneous and no openings through them were found.

The ultimate fibers appeared as slender threads with both ends pointed. The typical ends of the *Urena* fibers seem to differ from those of *Abroma augusta* and of *Kleinhofia hospita* in that the tip of the first is not symmetrically pointed, appearing to be curved. There are, of course, ends pointed symmetrically, but they are in the minority. The same peculiarities in thickness of cell walls and diameter of lumens within an individual ultimate as are encountered in the members of the *Sterculiaceæ* are also found in the ultimate cells of *Urena lobata*.

According to Mathews the fiber cells of its closely allied species, *U. sinuata*, are 1.1 to 3.2 millimeters

long, 0.009 to 0.024 millimeter broad, with 0.015 millimeter as the average breadth. The lumen of the fiber is very irregular in width, but mostly rather broad. As can be seen, the above dimensions agree almost exactly with those of the fiber cells of *U. lobata*. Schweitzer's solution produces a strong swelling of the cell wall of *U. sinuata*.

THE FIBER.

The fiber was extracted by retting the bark in water. In the dry state it appears a little yellowish and possesses a good amount of brilliancy. Water-retting required eighteen days. Fifty plants of each type were retted, and the branchy type gave 0.522 kilo of clean fibers, while the less branched one produced 1.127 kilos. These figures give the average yield per plant as 0.0165 kilo. If 336 plants could be gathered from 900 square meters of ground, then from 1 hectare enough plants could be gathered to produce 56.1 kilos of clean dry fiber. It must be understood that the figure for the number of plants was obtained in a count of plants on a space supposed to be well covered with *culut-culutan*. This calculation, it is perhaps needless to say, was made not to give a basis for possible production per unit of area, as distancing in the wild state is great. It is given here merely to suggest what yield one can expect from an area of wild *Urena lobata* growing as thickly as was observed near the college grounds. If regular plantings are to be made, a very much greater yield can be expected, as not only more plants can be grown per unit of area, but also the crop can be expected to produce a better yield. According to Royle, when plants are grown for fiber they are generally sown and

grown close together. This is done in order to favor their shooting upwards and to prevent their too great exposure to heat, light, and air, which favor the formation of the different secretions of the plant and the consequent hardening of the fibers.

HIBISCUS SABDARIFFA L. Roselle or Rozelle.

In the West Indies this plant is called red sorrel, while in the Madras territories it is given the name *rozelle* and *rouselle*. The latter is said to be a corruption of *oscille* (1). In Spanish it is called *rosella*. Roselle is of very recent introduction into the Philippines. The College of Agriculture received the first shipment of seeds from the Hawaiian Experiment Station, through Dr. F. W. Foxworthy. A successful planting was obtained from these seeds. *Hibiscus sabdariffa* is successfully cultivated in Java and in Florida (31). It has long been in cultivation in Mexico, parts of Central America, and in the West Indies (24), and is more or less widely cultivated in Hawaii. India, which is the native home of roselle, raises it chiefly for fiber.

The plant has been described by Merrill as "an erect, branched, glabrous, or nearly glabrous annual herb, 1 to 2 m. high, the stems purplish. Leaves 8 to 12 cm. long, polymorphous, entire to deeply 3- or 5-lobed, the lobes oblong to oblong-lanceolate, often free nearly to the base of the leaf, toothed. Peduncles axillary, solitary, much shorter than the petioles. Bracteoles 8 to 12, linear, adnate to the base of the calyx, about 1 cm. long, calyx somewhat hirsute, the lobes acuminate, connate below the middle into a fleshy cup. Corolla pink with a dark center about 5 cm.

long. Fruit ovoid, pointed, villous, about 2.5 cm. long, inclosed by the fleshy, acid, accrescent calyx." It flowers from November to January.

As a fiber plant *Hibiscus sabdariffa* has some advantages over the other species of *Hibiscus* in that the stems are erect and less branchy, and the plant has many other uses.

MICROSCOPIC STUDY.

(See Plate X.)

The bast cells are polygonal in shape and vary from 3-sided to 6-sided. Many cells are bounded by curved sides, giving them all sorts of irregularities in shape, and approaching, in some cases, a circle. The cells are 1.200 to 3.267 millimeters long, and 0.010 to 0.032 millimeter broad. The diameter of the lumens is 0.003 to 0.015 millimeter, while the thickness of the walls varies from 0.004 to 0.014 millimeter. Longitudinally the ultimate cells appear slender with pointed ends. In some fiber cells the diameter of the lumen exceeds the thickness of the cell wall. In other cases it is very small, forming a narrow double line. The cells are in compact masses or groups. Few intercellular spaces were found. There are four layers of these groups, the layers and groups being separated from one another by parenchyma cells. The deepest layer of bast group is the outermost one, and is 7 to 13 cells deep and 2 to 7 cells broad. The first layer of bast groups is 5 to 9 parenchyma cells distant from the outside of the section, while the last layer is separated from the wood by the same number of parenchyma cells. The cell walls are homogeneous, and, in many cases, unlike those fiber cells already described, openings through cell walls have been

found. The cells of the last layer, counting from the outside, are not in as compact groups as the first ones.

THE FIBER.

Eighteen plants from college nursery rows, retted in still water from July 18 to July 28, gave 104 grams of dry clean fibers. These fibers appeared almost as white as abaca and showed a considerable degree of brilliancy. The fibers of roselle are called, in the English-speaking countries, roselle hemp. Royle and Dr. Roxburgh have made studies of roselle hemp. According to the former(22) it compares favorably in strength with various cordage fibers as seen in the following table; the tests were made on ropes, of the same size and 1.2 meters in length:

	Comparative strength.	
	Dry.	Wet.
	Kilos.	Kilos.
<i>Hibiscus abelmoschus</i>	49	49
<i>Corchorus strictus</i>	47	52
<i>Hibiscus sabdariffa</i>	41	53
Sunn hemp (retted after drying)	27	35

Dr. Roxburgh's results were as follows(31):

	Breaking strains.	
	Dry.	Wet.
	Lbs.	Lbs.
<i>Hibiscus strictus</i>	104	115
<i>H. sabdariffa</i>	95	117
<i>H. furcatus</i>	89	92
Indian okra (<i>H. esculentus</i>)	79	95

The Imperial Institute of London has examined three samples of three varieties of *Hibiscus* fibers from Tamale, in the northern territories of the Gold Coast. Sample No. 1 was *Hibiscus sabdariffa*. Samples 1 and 2 were obtained from plants cultivated at the Experiment Station. No. 3 was prepared from wild plants.

For the first two samples, the plants ripened seventeen weeks after sowing. The chemical analysis of *Hibiscus sabdariffa*, compared with that of very fine Indian jute, gave the following results:

[Length of fiber: *Hibiscus* No. 1, 8 to 16 inches; extra fine jute, 6 to 16 inches.]

	<i>Hibiscus</i> No. 1.	Extra fine jute.
	Per cent.	Per cent.
Moisture	8.9	9.6
Ash	1.1	0.7
Loss by hydrolysis (a)	12.3	9.1
Loss by hydrolysis (b)	17.8	13.1
Loss by leeching with acid	1.5	2.0
Cellulose	73.9	72.7

Hibiscus sabdariffa fiber will find a ready sale as a substitute for *Hibiscus cannabinus* or Bimlipatan jute(31).

Wester(30) recommends planting roselle for calyces in rows 1.5 to 3 meters apart, the plants being 1 to 2.5 meters apart in row, thinning to one plant per hill. If grown for stems and leaves or for fiber, it is recommended to plant the seed thinly in drills 60 to 100 centimeters apart. If, as the author has found, 16 plants can produce 104 grams of fiber, then, raising them for this material, 1 hectare of land may be expected to yield 269 to 481 kilos of fiber, assuming that the plants in the drill are 20 centimeters apart, the distance at which the plants in the nursery row were growing. In the northern territories of the Gold Coast, a yield of 600 pounds per acre has been reported, which is equivalent to 654 kilos per hectare.

MALACHRA FASCIATA L.

There appear to be two species of *Malachra* in the Philippines—*M. fasciata* and *M. capitata*—growing as common weeds in waste places. Both are called by Tagalogs *paang-*

balinis, the former, however, is also called *sipit-ulang* by natives of Laguna Province. The name "sipit-ulang" is given in Rizal Province to a thorny vine whose roots are highly valued for medicine.

Shortly after the beginning of the rainy season, waste places and uncultivated rice fields can be seen more or less covered with these plants. Merrill states that *Malachra* is not reported elsewhere in the Orient, but is a native of tropical America. It flowers from September to January. Botanically, it is described as "a stout, erect, more or less branched, hirsute herb, 0.5 to 1 m. high. Leaves 10 to 15 cm. long, cut nearly to the base into 5 linear or oblong-linear lobes 5 to 15 mm. wide, the outer ones shorter than the inner, base obtuse or rounded. Flowers fasciated, axillary or on short axillary branches, each fascicle more or less inclosed by leafy bracts, the bracts with the basal, elongated, linear lobes. Corolla pink, about 1 cm. long."

In the marshy fields between the towns of Los Baños and Bay, Laguna Province, there are fields of wild *sipit-ulang* where the plants grow to about 3 meters high at distances of about 20 centimeters apart.

MICROSCOPIC STUDY.

(See Plate II, fig. 3.)

In the section examined, there are two distinct layers of bast groups which are in the inner layer of the bark. In some parts of the section, however, there are some groups which form an attempt at the formation of a third layer. The first layer is about 2 to 9 cells deep, while the second is only 2 to 6 cells deep. The groups are surrounded by parenchyma cells. The bast cells are polyg-

onal in shape, varying from those of 3 sides to those of 7. The latter is very rare, while the most common cells are pentagonal. Intercellular spaces are very common. A few groups, however, exhibit a fair degree of compactness. The ultimate cells are 1.200 to 5.087 millimeters long and 0.006 to 0.029 millimeter broad. The cell walls, which are homogeneous, are 0.001 to 0.013 millimeter thick, while the lumens are 0.002 to 0.015 millimeter in diameter.

THE FIBER.

In October plants about to flower were retted; the operation required fifteen days. The fibers were brilliant and silky, bearing a close resemblance in these respects and in color to the fibers of *Hibiscus sabdariffa*. They are almost as white as the fibers of abaca.

Of the 13 kinds of fibers under consideration, it was found that the fibers of *sipit-ulang* are the strongest. The untwisted fibers are about one-half as strong as the fibers of abaca. In cord form, *sipit-ulang* broke with 11,752 grams when the corresponding abaca cord broke with 17,625 grams.

The people in Los Baños and neighboring places know that the fiber of *sipit-ulang* is stronger than those of *labayo* or *anilao*, but it has not become popular among them on account of the extra work of retting. However, in cases where they need stronger fibers, they are obliged to ret *Malachra fasciata*.

In January, 220 plants, which retted in twenty-two to twenty-seven days, yielded 965 grams of dry fiber. At this rate and at distances at which they grow in nature (20 by 20 cm.) 1 hectare of *M. fasciata* would yield 1,095 kilos of fiber.

MALACHRA CAPITATA Jacq. Paang-baliuis Tag.

This species of *Malachra* differs from the other mainly in that the leaves of this one are not lobed.

The College of Agriculture received seeds of *M. capitata* from Morong, Rizal, through Mr. Agripino Constantino. These were planted on March 8, 1913, and the seeds were harvested on December 24, 1914, after ten and one-half months. It took five to eight days to germinate the seeds. Another planting was made on September, 1914, and the plants of this culture flowered in October, 1915, and were used in this work. They were planted in a nursery row, about 20 centimeters apart in the row.

MICROSCOPIC STUDY.

(See Plate III, fig. 11.)

The cross section examined was taken from a plant about 10 months old. From the cross section it appeared that there are three layers of bast groups, but in some parts of the section the second and the third layers (counting from the outside) cannot be seen. The groups are surrounded by parenchyma cells and separated from the wood by the cambium, on which in some parts the third layer abuts. The first layer is from 2 to 11 cells deep, the second 2 to 6 cells, while the third is 2 to 5. The cells, while they are not in compact masses, have only minute spaces between. Speaking of the entire group, the cells are fairly uniform in size except in some individual groups, where there is a great variability; in shape they are quite uniform, being polygonal with rounded corners. The cells are 0.007 to 0.029 millimeter broad and 1.560 to 4.493 millimeters long. The cell walls are from 0.003 to 0.011 millimeter thick,

while the diameter of the lumens varies from 0.002 to 0.011 millimeter. The cells of the group nearest to the wood have wider lumens and thinner walls than those outside them, and a greater total diameter of cells. The cell walls appear to be homogeneous, and pits are very rare.

THE FIBER.

In Morong, a town of Rizal Province where *Malachra capitata* is used for making cordage, the fiber is used in the unclean state. The bark is stripped from the plants and, without undergoing any process of cleaning, is dried and twisted into cords.

For purpose of this study fibers were extracted from plants growing in the nursery by retting in water. The fibers obtained were not as white as the fiber of roselle, but about as white as that of *Urena lobata*. In appearance they were silkier, and to the touch finer than any of the other fibers treated in this study. In September and October, it took nine and eleven days, respectively, for young plants to ret in water. From 28 plants retted, 25 grams of dry clean fiber were obtained. Assuming that plants grow 20 by 20 centimeters apart, as they are found in nature, 1 hectare of ground ought to yield 223 kilos of fiber.

TILIACEÆ.

TRIUMFETTA BARTRAMIA L. (T. rhomboidea Jacq.)

This plant is called in Tagalog by the same names as those applied to *Urena lobata*. It is found in tropical Asia, Africa, and Malaya.

It is "an erect, more or less hairy, branched, annual, often subfrutescent herb, 0.5 to 1.5 meters high. Leaves variable, usually orbicular or rhom-

boid-ovate, base rounded, apex 3-lobed, denticulate, the upper ones much reduced, oblong to ovate-lanceolate, not lobed. Flowers yellow, about 6 mm. long, numerous in rather dense axillary fascicles. Fruit small, globose, pubescent, covered with hooked spines, the spines glabrous." (29)

Like *Urena lobata*, *T. bartramia* is one of the commonest weeds of the Islands. It abounds in waste places and resists drought to a high degree. Although usually about 1.5 meters high, plants in thickets reach the height of more than 2.5 meters, and are more slender and less branched than those in the open places. It may be propagated by seeds or cuttings. Experiments along this line were made in June, 1915. From cuttings bearing 3 to 4 buds, 7 mainstems and 6 primary branches calloused, and the plants produced averaged 88 centimeters in height after six months. The plants respond to pollarding, but the shoots grew very slowly.

MICROSCOPIC STUDY.

(See Plate III, fig. 2.)

The cells in the cross section examined are in 41 to 43 pyramidal groups which point toward the outside, and are separated from one another by pyramidal groups of parenchyma cells and laid in the opposite direction. Each group is, in turn, subdivided into strips, likewise separated from one another by parenchyma cells. The size of the group varies from 1 to 6 strips, 4 strips being very common. The bast cells in each group may be said to be in a separate circular layer, lying horizontally. These layers vary from 4 to 10 in number in different sections. The cells vary in size gradually from the outside toward the pith. The

last layer is separated from the wood by the cambium, on which it abuts.

The bast cells are polygonal in shape, varying from those of 3 sides to those of 7. Pentagonal and hexagonal cells are the commonest. Few cells have their corners so rounded as to approach a nonpolygonal shape. In length the ultimate cells vary from 1.133 to 2.827 millimeters. They are 0.009 to 0.027 millimeter broad. The cell walls are 0.003 to 0.008 millimeter thick, while the diameter of the lumen is 0.001 to 0.006 millimeter. The cell walls are homogeneous.

THE FIBER.

Fibers were extracted by water-retting. It took from eighteen to twenty-two days to ret. The plants retted were at fruiting age. From 66 plants, 1.25 to 2.36 meters high, growing in neighboring localities, 667 grams of clean dry fibers were obtained. In this work, 28 flowering plants, about 2 meters high, yielded 109 grams of clean dry fiber. If plants are placed in rows 60 centimeters apart and 20 centimeters apart in the row, on the basis of the yield found, 1 hectare of land may be expected to yield 325 kilos of fiber. The fibers are so similar in appearance to those of *Urena lobata* that it is hard to distinguish one from the other. Upon close observation, however, it will be found that the fibers of *Urena lobata* are slightly more brilliant or more silky than those of *Triumfetta bartramia*.

GREWIA MULTIFLORA Juss. Dangli or Dangling, Tag:

Six species of *Grewia*, including that under consideration here, have been reported as useful fiber plants in the Philippines. *Grewia multiflora* is found from India to Africa

and Malaya, and throughout the Philippines.⁽²⁹⁾ Definite reports have come from Batangas, Bataan, Nueva Ecija, Rizal, and Laguna, where it is known as *dangling*; from Ilocos Sur, Pangasinan, Sorsogon, Union, and Zambales, where it is called *aliniao*; and from Pampanga, there known as *aplit* and *nagling*, and as *lanut* among the Negritos of the province. The Caddanes in Nueva Vizcaya call it *dallag*. In Tayabas it is called *kalit-kalit*; in Bohol, *langosig*; in Mindoro, *siapo*; and in Camarines and Albay, *tarpy*.

Grewia has been described⁽²⁹⁾ as "a shrub or small tree, 3 to 8 m. high, glabrous or nearly so. Leaves oblong-ovate to elliptic-ovate, 4 to 14 cm. long, 2.5 to 5 cm. wide, often somewhat equilateral in form, base usually rounded, 3-nerved, apex acuminate, margins crenate-serrate. Inflorescence of small, axillary, solitary umbels, the peduncles longer than the petioles, each with from 2 to 7 flowers. Buds globose or ovoid. Flowers about 1 cm. in diameter, greenish yellow. Sepals pubescent outside, much longer than the petals. Fruit obovoid, about 6 mm. long. Fl. Sept.-Dec."

It produces seeds readily, but may be propagated by cuttings. The cutting experiments resulted in the calousing of primary and secondary branches. It took only two days for the buds to come out, and the shoots averaged 70 centimeters after six months. The shoots produced after pollarding the plants grow slowly, although in good numbers.

MICROSCOPIC STUDY.

(See Plate III, fig. 3.)

The bast cells of *Grewia multiflora*, which are in the inner part of the bark, are polygonal in shape, vary-

ing from triangular to heptagonal. As in *Triumfetta bartramia*, the most common are those of 5 and 6 sides. The cells are in pyramidal groups which point toward the outside, and which are separated and surrounded by parenchyma cells. The separating groups are also pyramidal, but they point toward the center of the section. The cells are in compact masses. Small air spaces are found, but they are rare. The cell walls are homogeneous. The last layer of cells is separated from the wood by the cambium, on which it abuts at several places. The bast cells are 1.067 to 2.707 millimeters long and 0.006 to 0.024 millimeter broad. The cell walls are 0.001 to 0.010 millimeter thick, while the diameter of the lumen varies from 0.001 to 0.005 millimeter.

THE FIBER.

Fibers were obtained from trees growing on the Maquiling Reserve. It took, in September, four to six days to ret in water. The strips of the fibers of *Grewia multiflora* differ from those of other plants already reported in that the ultimate fibers are very much more compact, making the appearance of the strips very distinct. They appear fairly white, in strips as broad as 1.5 centimeters and 2 to 2.3 meters long.

As *dangling* is a slow-growing tree, and for this reason not a very promising plant to raise on a field scale, no attempt is made to determine the possible yield per hectare. A plant 5.5 meters high yielded 28 grams of dry fiber.

COLUMBIA SERRATIFOLIA (Cav.) Pers.

This plant is widely distributed throughout the Philippines and has been reported from Bulacan, Capiz, Iloilo, Nueva Ecija, Occidental Ne-

gros, and Isabela. The Tagalogs call it *anilao*; the Ilocanos in Isabela, *kedding*; the Ibans in Isabela, *panaguising*; the Visayans in Occidental Negros, *sargo*. It is described by Merrill as "a shrub or small tree 3 to 10 meters high, the branches and inflorescence hirsute. Leaves oblong-ovate to oblong-lanceolate, acuminate, 10 to 20 cm. long, base very oblique, margin coarsely or finely serrate, the upper surface becoming nearly glabrous, the lower surface pale, rather densely pubescent and hirsute. Panicles terminal and in the upper axils many flowered, 10 to 30 cm. long. Flowers clustered, 6 to 7 mm. Sepals pubescent. Petals pink and yellowish or reddish. Capsules about 1 cm. long, broader than long, 3- or 4-winged It flowers from May to July."

Columbia serratifolia, like *Melochia umbellata*, grows commonly in second-growth forests.

MICROSCOPIC STUDY.

(See Plate IV, fig. 1.)

In general appearance the section of *Columbia serratifolia* examined resembles those of the other members of *Tiliaceae* already reported—*Grewia multiflora* and especially *Triumfetta bartramia*.

The bast cells are in 45 pyramidal to narrow rectangular groups. However, in *Triumfetta bartramia* there were 41 of these groups and, as in the latter, each group is subdivided into strips from 2 to 10 in number. There are 1-strip groups also. The space between strips, occupied by parenchyma cells, varies in width from several cells to mere black lines. The groups are pyramidal in shape, occupying almost the whole thickness of the bark and pointing toward the outside of the section. The paren-

chyma cells which separate the groups and surround them in most places are usually pyramidal in shape also, but pointing toward the center of the section. There are a few points in the section where the cambium layer is almost interrupted to such an extent as to show that the bast cells are in direct contact with the wood. Some of the lower cells of the group abut in the cambium layer.

The bast cells are polygonal, from triangular to 7-sided; pentagonal cells are the most frequent. The bast cells are in compact masses and are, on the average, 1.593 millimeters long and 0.014 millimeter broad, but the length varies from 0.960 to 2.533 millimeters, the breadth from 0.005 to 0.027 millimeter. The cell walls are homogeneous, and, where no openings were found, are from 0.001 to 0.009 millimeter thick, and the lumens from 0.001 to 0.008 millimeter in diameter. Intercellular spaces are very rare.

The ultimate cells, in longitudinal view, do not differ from those of *Triumfetta bartramia*. As in the latter, there are ultimate cells with broad lumen which exceeds the thickness of the cell walls, while there are cells where the lumens are quite narrow as to form, in extreme cases almost a double line. Ridges along the sides and at the ends are quite common. Some ridges are so distinct as to form long projections, amounting almost to branches. Among the hundreds of ultimate cells examined, there were only two where there were openings existing below the branch-like abnormalities.

THE FIBER.

The fibers used in this work and made into exhibitable cords were stripped from the bark of trees grow-

ing in a second-growth forest in the Maquiling Reserve. They were obtained in the form of long strips about 1.5 to 2.5 meters long, 2 millimeters thick, and 2 to 8 centimeters broad. In the fresh condition, the fiber strips appear yellowish, but upon drying they turn to pale brown. The fibers of *Columbia serratifolia* and of *Melochia umbellata* needed no further cleaning before they were made into cords, as they come out easily into fine strips, with no sign of impurity with them. This is especially true with *Melochia umbellata*. In the case of the strips of *Columbia serratifolia*, the separation into thinner and narrower strips, which must be done if they are to be made into cords of good appearance, should be made while the fibers are fresh, for they become stiff and brittle upon drying. In fact, the natives usually twist them into cord early in the morning or when there is not too much heat, otherwise the cords easily break before twisting can be completed. Wetting dry fibers tends to restore them to the fresh condition. In the dry condition it has been found that it is the weakest of all fibers reported in this work.

As in the case of *Melochia umbellata*, no attempt was made to determine the possible yield per hectare of the plants. Excepting *labayo*, *anilao* fiber is the most popular fiber in Los Baños and surrounding towns, although those who use it admit that cords made of it are weaker and less durable than those made of either *danling* or *labayo*.

URTICACEÆ.

PIPTURUS ARBORESCENS (Link) C. B. Rob. (*P. asper* Wedd.)

The Tagalogs call this plant *dalunut* or *dahunot*. It has not been

reported as a fiber plant in the Philippines, although it is found throughout the Islands. It has been reported from Batanes Islands, Babuyan Islands, Ilocos Norte, Ilocos Sur, Bontoc, Lepanto, Benguet, Union, Pangasinan, Bulacan, Bataan, Rizal, Laguna, Batangas, Tayabas, Camarines, Mindoro, Negros, Cebu, Surigao, Lanao, Zamboanga, Cotabato, Basilan, Palawan, and Borneo.

It is "a dioecious shrub or small tree 3 to 5 m. high. Leaves ovate, 7 to 18 cm. long, 3 to 10 cm. wide, sharply acuminate, base rounded or somewhat cordate, the margins toothed, the upper surface green, or slightly pubescent, a little scabrid, the lower surface pale, rather densely and softly pubescent. Male flowers in dense, axillary fascicles, the styles greenish white, exserted. Female flowers small, greenish, in dense axillary, hemispheric heads 5 to 6 mm. in diameter, the styles long exserted. Fruit white, very soft and fleshy, depressed-globose, 1 cm. in diameter or less. Flowers all the year." (29)

The plant propagates by seeds, but may be multiplied also by cuttings. The plants produced in this manner averaged 55 centimeters in height after five months. A plant cut June 8, 1915, produced 2 shoots July 2 of the same year. In twenty days these shoots grew only to about 2 decimeters.

MICROSCOPIC STUDY.

(See Plate IV, fig. 2.)

The bark of *dahunot* is thinner than those of the members of the families already studied. The bast cells are not polygonal in shape. They vary from those approaching a circle to those of various irregular shapes. The figure alone can convey an idea

of the different shapes exhibited by the cells. The bast cells are 3.773 to 6.00 millimeters long, and 0.010 to 0.042 millimeter broad. The cell walls, which are formed of many layers, are 0.010 to 0.022 millimeter thick while the diameter of the lumens varies from 0.017 to 0.078 millimeter.

The bast cells are not massed in separate groups, but form a layer 3 to 8 cells deep, the layer having only one break in the section examined. The cells do not lie in a compact mass and do not have any definite position relative to the layers of cells above and below. Some are parallel, others make various angles with the bounding cell layers. No cell was found which contained pits. The bast is surrounded by parenchyma cells and separated from the wood by the cambium layer.

THE FIBER.

The writer has so far failed to extract any fiber from the bark of *dalunot* by water-retting. Materials placed in the water decay without leaving the bast.

LEGUMINOSEÆ.

SESBANIA GRANDIFLORA Pers.⁽¹⁾
Caturay, Tag. *Gauay-gauay*, Vis.

Sesbania grandiflora has not been reported as a fiber plant in the Philippines. The species of *Sesbania* in the Islands from which fiber is extracted is *S. aegyptiaca* Pers., called by the Visayans by the name of *malucadios*. This is a small shrub and was reported from the Island of Masbate. *Sesbania achleata*, which is a native of the Malabar coast, produces a strong useful fiber, the dhunchee fiber of Bengal, and is used as a substitute for hemp.

Caturay is half wild and half cultivated. It grows throughout the Philippines, but is not a native here, though of prehistoric introduction. It is found also in Malaya and Australia and from India west to Mauritius.

It is described by Merrill as "a glabrous tree 5 to 12 m. high. Leaves 2 to 30 cm. long. Leaflets 20 to 40 pairs, oblong, obtuse, pale green, 2.5 to 3.5 cm. long. Racemes short, axillary. Flowers few, very large, white, 7 to 9 cm. long. Calyx green, subtruncate or very shallowly 2-tipped. Pod pendulous, linear, 20 to 60 cm. long, 7 to 8 mm. wide, somewhat curved, many seeded." It flowers from October to April.

Sesbania grandiflora, being a member of the legume family, is more or less of a soil renovator. It is this important use of the plant that impelled the author to investigate its fiber.

The College of Agriculture received on December 2, 1912, a packet of seeds of *S. grandiflora* from the Empress Botanical Garden, Poona. The first planting was made on the day of the receipt. The seeds germinated three days after planting. The plants flowered February 24, 1913, and from April to May of 1913 and May to June of 1914 seeds were harvested to the amount of 110-220 grams (selected seeds), from 21 plants, covering 50 square meters of ground. Another planting was made on April 30, 1913, which germinated after four days. The plants were potted on May 12, 1913, and transplanted to nursery rows on June 28 of the same year. These plants began to flower on October 10, 1913, and seed harvest began on April 13, 1914. From 21 plants, covering 56 square meters

of land, 275 grams of selected seeds were gathered.

MICROSCOPIC STUDY.

The bast cells are in the inner layer of the bark. In the sections examined, there were 45 to 47 groups, more or less fan-like in shape, with the base near the wood. The groups differ from those of the members of the *Sterculiaceæ*, *Malvaceæ*, and other families studied, in that they are not subdivided into strips of minor groups. Each group appeared to be almost a compact mass of cells, with few intercellular spaces. The groups are surrounded by parenchyma cells, their bases abutting on the cambium.

The cells are polygonal in shape varying from triangles to hexagons. The triangular ones are very rare. The quadrilaterals and pentagons are found mostly at the outer part of the group, while the cells of 7 sides are found at or about the middle of the mass.

The ultimate cells are 1.800 to 3.760 millimeters long and 0.008 to 0.037 mm. broad. The cell walls are 0.002 to 0.008 millimeter thick. The lumens are 0.001 to 0.023 millimeter in diameter. In each cell the wall is uniform in thickness. The cell cavity, unlike those of the bast cells of other plants, follows very closely the shape of the cell.

The bast groups vary in size from those of about 5 cells thick and 5 cells long to those 36 cells long and 11 cells thick. There are groups longer than these, reaching 60 cells in length, but they are thin, only about 9 cells deep.

The cell walls are heterogeneous, consisting of layers. The number of layers could not be ascertained. Some cells have pits.

THE FIBER.

Materials from both trunk and branches of a tree about two years old were retted in running water, but only from primary and secondary branches were fibers obtained. The bark from the trunk remained hard when that of the branches was ready. It took from five to eight days to ret. The fibers are extremely coarse, resembling in this respect the coconut coir. They are about 0.75 meter long, fairly white, but devoid of any brilliancy. Because of the coarseness of caturay fiber, it is believed that it would be useless for cord. No attempt, therefore, was made to test its strength. The writer knows of no purpose which caturay fibers might serve and at the same time justify the employment of the labor of retting the bark.

From the secondary and primary branches of two plants in fruit 59 grams of fiber were obtained.

THYMELEACEÆ.

WIKSTROEMIA OVATA C. A. Mey.

According to Dr. Foxworthy, this is a small shrub of occasional occurrence in thickets and at the edge of the forest. Other members of the family are found as shrubs in the forest and are noted for the exceeding toughness of their bark. Dr. Copeland speaks of a species of *Wikstroemia*, very likely *W. ovata*, which grows abundantly at the edge of Mount Banahao forests.

MICROSCOPIC STUDY.

(See Plate IV, fig. 3.)

The bast cells are in slender pyramidal groups which occupy almost the whole thickness of the bark, and lie in about the same position as that of the pyramidal groups of other plants examined. In the groups, the bast

cells appear to be more scattered and are not numerous. They are polygonal, varying from those of 3 sides to those of 6; 4- and 5-sided cells are the commonest. The cell walls are homogeneous and vary in thickness from 0.001 to 0.01 millimeter, the diameter of the lumen from 0.001 to 0.004 millimeter. The ultimate fibers are 1.653 to 4.24 millimeters long and 0.003 to 0.021 millimeter in total diameter. Comparing these measurements with the corresponding ones for the other 12 fibers studied, it can be seen that the ultimate fibers of *Wikstroemia ovata* have the least average diameter and are exceeded in length by *Pipturus arborescens*, *Malachra fasciata*, and *Malachra capitata*. The properties of this fiber

ought to make it a very useful textile fiber, assuming that the other properties are satisfactory.

THE FIBER.

As there is only one plant of *Wikstroemia ovata* on the whole college campus, and that is growing as a plant specimen in the forestry arboretum, and on other plants having been found fiber extraction was not attempted.

STUDY OF FIBERS COLLECTIVELY.

In order that the different fibers studied may be compared easily as to their size (length and diameter), the maximum, mean, and minimum of their dimensions have been tabulated below:

TABLE I.—Dimensions of bast fibers studied.

Fibers.	Length.			Diameter.					
				Total.			Lumen.		
	Maxi- mum.	Aver- age.	Mini- mum.	Maxi- mum.	Aver- age.	Mini- mum.	Maxi- mum.	Aver- age.	Mini- mum.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
<i>Abroma augusta</i>	4.240	2.213	1.360	0.089	0.017	0.006	0.001	0.005	0.002
<i>Kleinhofia hospita</i>	2.400	1.518	.933	.081	.015	.008	.007	.005	.001
<i>Melochia umbellata</i>	3.067	2.045	1.107	.027	.016	.011	.012	.007	.003
<i>Urena lobata</i>	2.547	1.442	.973	.027	.013	.009	.005	.003	.002
<i>Hibiscus sabdariffa</i>	3.267	1.928	1.200	.032	.020	.010	.015	.008	.003
<i>Malachra capitata</i>	4.493	2.758	1.560	.029	.015	.007	.011	.007	.002
<i>Triumfetta bartramia</i>	2.827	2.027	1.133	.027	.016	.009	.006	.004	.001
<i>Grewia multiflora</i>	2.707	1.843	1.067	.024	.015	.006	.005	.003	.001
<i>Pipturus arborescens</i>	6.000	5.054	3.773	.100	.069	.042	.078	.044	.017
<i>Sesbania grandiflora</i>	3.760	2.737	1.800	.037	.022	.008	.023	.010	.001
<i>Columbia serratifolia</i>	2.533	1.593	.960	.027	.014	.005	.001	.004	.003
<i>Malachra fasciata</i>	5.067	2.014	1.200	.042	.016	.006	.015	.007	.003
<i>Wikstroemia ovata</i>	4.240	2.972	1.653	.021	.012	.003	.004	.002	.001

Following are two tables, one giving the dimensions of ultimate fibers of some Philippine fiber plants and another containing corresponding dimensions of some of the most important industrial fibers of other countries.

From a study of the three preceding tables, it may be concluded that:

1. The longest fibers of *Pipturus arborescens* are as long as the longest ultimate fibers of abaca. On the

average, however, the former are shorter than the latter and compare favorably with Gambo hemp.

2. In average length, fibers of *Abroma augusta*, *Melochia umbellata*, *Malachra capitata*, *Triumfetta bartramia*, *Sesbania grandiflora*, *Malachra fasciata*, and *Wikstroemia ovata* compare very favorably with the fibers of maguey, dwarf bamboo, and buri palm, and of jute and Spanish grass.

TABLE II.—*Dimensions of the ultimate fibers of some Philippine fiber plants.*

[Table by Dr. E. B. Copeland. (24)]

Name.	Length.			Diameter.					
	Maxi-mum.	Aver-age.	Mini-mum.	Total.			Lumen.		
				Maxi-mum.	Aver-age.	Mini-mum.	Maxi-mum.	Aver-age.	Mini-mum.
Abaca (<i>Musa textilis</i>)	mm. 6.00	mm. 3.98	mm. 2.45	mm. 0.021	mm. 0.017	mm.	mm. 0.009	mm. 0.0066	mm.
Plantain (<i>Musa Sapientum</i> , var. pa- radisiaca)	7.30	5.49	4.15	.026	.020	0.018	.016	.0106	0.007
Maguey (<i>Agave cantala</i>)	4.93	2.86	1.00	.026	.018	.015	.013	.007	.004
Cogon grass (<i>Imperata exaltata</i>)	1.82	.99	.46	.021	.011	.005	.013	.0044	.001
Talahib (<i>Saccharum spontaneum</i>)	2.82	1.59	.80	.020	.015	.012	.010	.0043	.0115
Bamboo (<i>Bambusa blumeana</i>)		1.81		*	.005				
Dwarf bamboo (<i>B. lumanpao</i>)	4.1	2.57	1.20	.028	.0156	.005	.025	.018	.001
Rise straw (<i>Oryza sativa</i>)		.88			.0025				
Buri palm (<i>Corypha umbraculifera</i>) ..	2.80	2.11	1.10	.015	.013	.01	.007	.0084	.002

TABLE III.—*Dimensions of some of the more important fibers used in the manufacture of textiles and paper.*

[Taken from M. Vetillart (10) and from De Bary (12).]

Name.	Length.			Diameter of fiber cell.		
	Maxi-mum.	Aver-age.	Mini-mum.	Maxi-mum.	Aver-age.	Mini-mum.
Flax (<i>Linum usitatissimum</i>)	mm. 66.0	mm. 25.30	mm. 4.0	mm. 0.037	mm. 0.022	mm. 0.015
Hemp (<i>Cannabis sativa</i>)	55.0	22.00	5.0	.050	.022	.016
Jute (<i>Corchorus olitorius</i>)	5.0	2.00	1.3	.025	.020	.020
Esparto grass (<i>Stipa tenacissima</i>)	3.5	.50	1.3	.018	.0125	.007
Spanish grass (<i>Lygeum spartum</i>)	4.5	2.5	1.3	.020	.016	.012
Bowstring hemp (<i>Sansevieria</i> sp.)	6.0	3.0	1.5	.026	.026	.015
Paper mulberry (<i>Broussonetia papyrifea</i>) ..	25.0	15.0	6.0	.035	.030	.025
Talipot palm (<i>Corypha umbraculifera</i>) ..	5.0	3.0	1.5	.028	.025	.016
Coconut palm (<i>Cocos nucifera</i>)	1.0	7.0	1.4	.024	.020	.012
Gambo hemp (<i>Hibiscus cannabinus</i>)		6.0		.016		.014
Sunn hemp (<i>Crotalaria juncea</i>)				.050		.013
Hop fiber				.030		.023
Spanish broom (<i>Spartium junceum</i>)				.020	.017	

3. The range of variability in the average diameter of the ultimate fibers of the 13 bast fiber plants reported in wider than in that of the Philippine monocotyledonous fiber plants and textile fiber plants of other countries.

4. The ultimate fibers of *Wikstroemia ovata* have the least average diameter of cells among the bast fiber plants studied and has a shorter diameter than most of the fibers reported in the last two preceding tables.

STUDY OF TENSILE STRENGTH.

This consists of a study of the comparative tensile strength of untwisted fibers and of cord made of them, the latter in either raw or dyed condi-

tion, and of a study of their comparative durability. In all of these cases, the material was one-half meter long, but the breaking weights, which were found on the basis of 1 gram of the material, were reduced afterwards to the basis of 1 meter length of the fibers or cord. Each of the figures appearing in the following table is an average of 5 or 6 determinations. For each kind of fiber, at least 10 determinations were made, but only those results which did not greatly deviate from each other were averaged.

The cords used were twisted by hand only, but they were made as uniform in diameter as could possibly be done.

The solution used in tanning the cords was obtained by boiling in water, for two and one-half hours, pieces of bark of *duhat* (*Eugenia jambolana*) and *camachile* (*Pithecolobium dulce*). The cords were immersed in the solution for twenty-four hours and dried before the strength was tested.

TABLE IV.—Averages of breaking weights.

[On basis of 1 meter cord and 1 gram weight. Obtained by dividing the averages of breaking weights, on basis of one-half meter cord and 1 gram weight, by 2. Assuming that the weights of the cords are equal, the length varies inversely with the breaking strain.]

Name.	Breaking strain.			
	Un-dressed.	Un-twisted strips.	Dyed twisted cords.	After exposure to weather for 83 days.
	Grams.	Grams.	Grams.	Grams.
Musa textilis	17,625	21,480	14,155	
Malachra fasciata	11,752	9,739	12,691	7,805
Malachra capitata	9,654	5,372	7,091	8,378
Triumfetta bartramia	7,885	9,392	9,402	7,314
Urena lobata	7,454	8,411	10,691	7,397
Kleinhofia hospita	7,441	5,993	6,796	6,195
Grewia multiflora	7,263	9,178	6,057	4,951
Hibiscus sabdariffa	7,140	7,903	8,323	6,567
Abroma augusta	6,962	6,731	7,649	6,611
Melochia umbellata	4,264	4,305	6,883	2,996
Columbia serratifolia	3,710	5,885	5,917	3,510

The percentage of deterioration of each fiber was figured out by subtracting the figures in the last column from the corresponding ones in the first, dividing the differences by those in the first, and multiplying the quotients by 100. In the order of durability the fibers stand as follows:

Fibers.	Deterioration.
	Per cent.
1. Urena lobata	0.7
2. Columbia serratifolia	5.0
3. Abroma augusta	5.0
4. Triumfetta bartramia	7.0
5. Hibiscus sabdariffa	8.0
6. Malachra capitata	13.0
7. Kleinhofia hospita	16.0
8. Grewia multiflora	31.0
9. Melochia umbellata	31.0
10. Malachra fasciata	33.0

From Table IV, we may conclude:
1. The breaking weight of the un-

twisted fibers of a plant may be different from that of the twisted fibers.

2. In cases of *Kleinhofia hospita*, *Grewia multiflora*, and *Malachra capitata*, tanning had a weakening influence, while in all other cases it had a decided strengthening effect.

3. Among the 10 fibers studied, the fiber of *Malachra fasciata* is the strongest, while those of *Columbia serratifolia* and *Melochia umbellata* are the weakest.

4. No one of the bast fibers under consideration is stronger than the fiber of abaca.

5. Of the fiber tested, the fiber of *Urena lobata* is the most durable, while that of *Malachra fasciata* is the least so.

SEASONAL RETTINGS.

With the object of determining the seasons in which the different fibers require the least amount of time for retting, monthly rettings of bark of such fiber plants of different ages as are available were carried out. All were in running creek water. Table V (p. 29) gives the names of such plants as were treated and the number of days required in retting in each month. The last column gives the months in which the retting required the least number of days.

IMPORTED FIBERS.

Cord samples of 18 different kinds of "hemp" were obtained in October from the Collector of Customs, representing importations from the countries named below:

Country.	Sam-ples.
China	6
Japan	5
England	2
Germany	2
France	1
Belgium	1
Spain	1

TABLE V.—Results of monthly rettings.

Name.	July.	August.	September.	October.	November.	December.	January.	Least number of days retting.
	Days.	Days.	Days.	Days.	Days.	Days.	Days.	
<i>Abroma augusta</i> :								
Young.....			11	4	9	6	12	October.
In flower.....				6		8	12	October.
Fruiting.....		8		6			12	October.
<i>Kleinhofia hospita</i> :								
Young.....			12			11	12	December.
In flower.....		11	10				12	September.
Fruiting.....			13					
Fruited.....						12		
<i>Grewia multiflora</i> :								
Fruited.....			5	4	5		7	October.
<i>Malachra fasciata</i> :								
About to flower.....				15				
Flowering.....							23	
<i>Malachra capitata</i> :								
Young.....			9	11				September.
In flower.....						12	21	
<i>Hibiscus sabdariffa</i> :								
In flower.....	10		8	11				September.
<i>Triumfetta bartramia</i> :								
Fruited.....		20	9	10	13	13	13	September.
<i>Urena lobata</i> :								
Fruited.....		18		7				October.
<i>Sesbania grandiflora</i> :								
Fruited.....	9	7	7	5	6	8	9	October.

According to the employee who supplied the samples, one of the two from England is jute. With this exception, the writer was unable to learn the name of the plants from which the fibers in the different samples were obtained. Neither were we able to learn the quantity and price of each kind imported.

According to the author's experience and observation the samples may be divided, according to use, among the following groups:

For net manufacture: 5 samples from China.

Shoe manufacture: 1 sample from Japan.

Sewing rice bags: 1 sample from Japan.

For tying purposes: 2 samples from Germany, 2 samples from Japan, and 2 samples from England.

The rest are for various purposes. Measurements of the diameter and number of strands of which the cords are composed have been made and the results are tabulated as follows:

Country.	No. of sample.	No. of strands	Diameter.
			mm.
Spain.....	1	3	2.0
Belgium.....	1	3	6.0
France.....	1	3	^a 1.5
Germany.....	1	3	1.5
Do.....	1	2	2.0
England.....	1	2	4.0
Do.....	1	2	3.5
Japan.....	1	2	3.0
Do.....	1	3	^a 1.5
Do.....	1	2	1.5
Do.....	1	2	2.5
Do.....	1	1	0.5
China.....	2	2	2.5
Do.....	2	2	0.7
Do.....	1	2	0.9
Do.....	1	2	0.8

^a Loosely twisted.

The author made an earnest attempt to identify these imported fibers by using the table for identification given in Mathews(22) and the reagents prescribed therein, but the outline proved to be inadequate. Neither is other literature available that can serve the purpose. This is most unfortunate as it is almost impossible to determine fairly whether we have in these Islands bast fibers which would compare favorably with

those of other countries while the latter remain unidentified.

GROWING OF PLANTS.

Because of failure to extract fibers of *Wikstroemia ovata* and *Pipturus arborescens*, and because *Sesbania grandiflora* is decidedly not to be classed with fiber plants, these three will be left out of this discussion.

Regarding *Melochia umbellata*, *Triumfetta bartramia*, *Urena lobata*, *Malachra fasciata*, *Malachra capitata*, *Grewia multiflora*, and *Columbia seratifolia*, these abound in their respective localities, so that just at the present time their planting need not be considered as an economic proposition.

Hibiscus sabdariffa may be grown exclusively for fibers or for calyces and fibers. In the latter case no consideration need be made of the cost

of planting, as this is to be counted against the production of the fruits. In the former case no data are available to show the average cost of planting a hectare of ground. This is likewise true of *Kleinhofia hospita* and *Abroma augusta*.

An absence of estimates of the cost of planting these different fiber plants per unit area of land does not alter the conclusion reached at the end of this discussion.

The following are tabulated figures representing probable cost of retting of the different fiber plants and that of the manufacture of fibers into salable cords. The last column contains the probable value of the cords themselves. All figures were obtained through estimates based on actual experience and reduced to the basis of 1 hectare:

TABLE VI.—*Expenses in retting and manufacture of cord and cost of cord.*

[The figures representing the number of plants and the yield of fiber in kilograms per hectare were gathered from the separate discussions of individual plants.]

Name of fiber plants.	Number of plants per hectare.	Cost of retting.	Yield of fiber.	Cost of manufacture.	Total expenses.	Value of cord.
			Kilo.			
<i>Abroma augusta</i>	2,500	P3.46	115	P35.77	P39.23	P33.50
<i>Kleinhofia hospita</i>	2,500	60.00	185	54.24	114.24	74.00
<i>Urena lobata</i>	3,696	2.02	56.1	67.73	69.75	16.83
<i>Hibiscus sabdariffa</i>	33,500	80.00	481	140.94	232.69	144.30
<i>Malachra fasciata</i>	250,000	264.00	1,095	301.34	565.34	657.00
<i>Malachra capitata</i>	250,000	264.00	223	65.03	329.03	89.00
<i>Triumfetta bartramia</i>	33,500	43.20	325	95.36	138.56	97.50

In figuring out the cost of retting and of manufacture of cord, it is assumed that a man's labor is worth 80 centavos per day, working nine hours a day. The value of the cord was based on the actual market price of *labayo* (*Melochia umbellata*), which is 20 centavos a kilo. However, since the other fibers are not of the same strength as *labayo*, it is assumed that they ought to command a price proportional to their tensile strength. In other words, when *labayo* sells for 20 centavos a kilo,

if a fiber is twice stronger than *labayo*, it ought to sell for twice 20 centavos, or 40 centavos.

Melochia umbellata, *Columbia seratifolia*, and *Grewia multiflora* are not included in the above table, as it is not assumed that they will ever be grown on the hectare basis. In the case of these three plants the consideration should be as to whether or not a man can earn more than 80 centavos a day by going into the collection and manufacture of fibers of these three plants. From the

writer's observations, and from the information received from the local farmers, the following figures can be given:

	Me- loch- ia um- bell- ata.	Colum- bia ser- ratifo- lia.	Grewia multi- flora.
Amount of fiber a man collect a day (dried)..... kilo	16	16	16
Cost of retting.....	none.	none.	P1. 60
Cost of manufacture in to cord.....	P4. 53	P4. 53	P4. 53
Total expenses.....	P4. 53	P4. 53	P6. 13
Value of cord.....	P3. 20	P2. 24	P5. 44
Gain or loss.....	loss.	loss.	loss.

From the preceding figures, and from the contents of Table VI, it may be concluded that employing labor at 80 centavos a day to raise these plants for fiber will not pay. This becomes more so if the cost of gathering the materials and of hauling them to the retting place and the interest on the value of the land be taken into consideration.

As regards a man's going into fiber collection and manufacture of fibers of *labayo*, *anilao*, and *danling*, it can be seen that such work is not as paying as employment at 80 centavos a day. However, it is probable that this work will remain for a long time as a home industry.

It appears that the cords of *anilao* and *labayo* now in the market are sold to purchasers by the farmers working in *caingins*, who adopt cord making as a side-employment.

SUMMARY.

1. The ultimate fibers of 13 Philippine bast fiber plants have been studied as regards their dimensions and those of their parts.

2. The comparative durability and tensile strength of 10 of these fibers, as well as of abaca, in the raw-twisted, untwisted, and dyedtwisted conditions have likewise been determined.

3. The time required to ret in water

11 of these fibers in several months has been determined. Fibers of *Pipturus arborescens* cannot be extracted by water-retting.

4. The fiber of *Sesbania grandiflora* is not a textile fiber.

5. It will not pay to raise any of the plants reported in this work for fiber, if the 80-centavo-a-day labor and the native method of cord manufacture are to be employed; neither is it more profitable for a man to go into collection of fibers and manufacture of cord or *labayo*, *anilao* and *danling* than to work for 80 centavos a day.

6. Almost all of the fibers imported into the Philippine Islands are not identified, and methods and literature for their proper identification are not available.

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The author desires to express his obligations to Professor Edwin B. Copeland and Assistant Professor Frederick W. Foxworthy, his present and former advisers, and to Professor Charles F. Baker, under whom this work was undertaken, for their valuable advice and criticisms.

APPENDIX: DETAILS OF MEASUREMENTS.

[Tables VII (a) to VII (m) contain measurements of cells in cross sections, while Tables VIII (a) to VIII (m) contain measurements of ultimate fibers obtained by maceration.]

TABLE VII (a).—*Bast cells of Abroma augusta.*

Cell No.	Thick- ness of cell wall.	Diam- eter of lumen.	Total diam- eter of cells.
	μ	μ	μ
1.....	a 6.1	11.4	23.7
2.....	b 1.5	2.3	6.1
3.....	6.1	6.1	19.8
4.....	5.6	6.9	18.3
5.....	5.6	5.6	16.8
6.....	5.6	5.2	15.3
7.....	6.9	1.8	13.7
8.....	3.0	3.0	9.9
9.....	3.8	2.3	9.2
10.....	3.0	1.2	7.6
Average.....	4.7	4.6	14.0

^a Largest.

^b Smallest.

TABLE VII (b).—*Bast cells of Kleinhofia hospita*

Cell No.	Thick-ness of cell wall.	Diam-eter of lumen.	Total diam-eter of cells.
	μ	μ	μ
1	^a 3.0	1.5	7.6
2	^b 12.2	6.7	31.1
3	10.7	6.1	25.2
4	10.7	6.1	20.6
5	7.6	3.7	19.8
6	7.6	3.8	16.0
7	4.9	4.6	12.2
8	7.6	4.6	16.8
9	7.6	5.6	18.6
10	6.1	3.8	15.3
Average	7.8	4.6	18.3

^a Smallest.

^b Largest.

TABLE VII (c).—*Bast cells of Melochia umbellata*.

Cell No.	Thick-ness of cell wall.	Diam-eter of lumen.	Total diam-eter of cells.
	μ	μ	μ
1	4.6	3.5	10.7
2	6.1	12.2	22.9
3	4.6	7.6	18.3
4	3.8	6.1	18.3
5	2.9	5.6	18.6
6	7.3	7.6	18.8
7	4.0	6.1	16.6
8	6.9	8.4	22.9
9	4.4	8.4	16.0
10	4.0	4.6	13.7
Average	4.9	7.0	17.7

TABLE VII (d).—*Bast cells of Urena lobata*.

Cell No.	Thick-ness of cell wall.	Diam-eter of lumen.	Total diam-eter of cells.
	μ	μ	μ
1	^a 3.3	2.9	9.2
2	^b 11.4	3.8	27.5
3	6.1	2.9	18.3
4	7.6	3.8	19.8
5	8.2	4.4	19.8
6	6.1	4.6	17.5
7	5.6	3.0	20.6
8	6.4	3.0	15.3
9	5.6	4.3	15.3
10	5.6	2.3	13.7
Average	6.6	3.5	17.7

^a Smallest.

^b Largest.

TABLE VII (e).—*Bast cells of Hibiscus sabdariffa*.

Cell No.	Thick-ness of cell wall.	Diam-eter of lumen.	Total diam-eter of cells.
	μ	μ	μ
1	^a 4.4	2.6	10.7
2	^b 14.3	5.2	32.5
3	11.4	7.5	23.7
4	9.2	11.6	27.5
5	9.3	8.4	25.2
6	8.4	13.4	27.5
7	7.6	11.3	23.5
8	6.9	15.3	27.5
9	9.9	3.0	16.8
10	7.6	2.7	29.0
Average	8.9	8.1	24.4

^a Smallest.

^b Largest.

TABLE VII (f).—*Bast cells of Malachra fasciata*.

Cell No.	Thick-ness of cell wall.	Diam-eter of lumen.	Total diam-eter of cells.
	μ	μ	μ
1	13.7	15.3	42.0
2	1.5	2.6	6.1
3	5.6	6.1	14.5
4	6.1	6.1	16.8
5	4.6	3.5	11.4
6	7.6	9.9	21.4
7	3.0	4.8	12.2
8	7.6	9.9	22.9
9	4.6	6.1	16.0
10	5.6	3.0	12.2
Average	6.0	6.7	17.5

TABLE VII (g).—*Bast cells of Malachra capitata*.

Cell No.	Thick-ness of cell wall.	Diam-eter of lumen.	Total diam-eter of cells.
	μ	μ	μ
1	^a 2.7	2.3	6.9
2	^b 11.4	11.0	29.0
3	7.6	5.6	16.8
4	9.2	4.6	18.3
5	9.2	9.2	22.9
6	5.5	4.9	14.2
7	7.6	8.4	20.8
8	6.9	3.0	15.3
9	6.9	11.4	26.0
10	7.6	11.1	26.0
Average	7.5	7.1	19.6

^a Smallest.

^b Largest.

TABLE VII (h).—*Bast cells of Triumfetta bartramia.*

Cell No.	Thick- ness of cell wall.	Diam- eter of lumen.	Total diam- eter of cells.
	μ	μ	μ
1	^a 3.0	1.5	9.2
2	^b 8.4	4.6	21.4
3	6.9	5.8	20.6
4	6.1	4.6	13.7
5	6.6	4.6	17.2
6	6.9	5.0	16.8
7	6.1	4.6	18.3
8	6.1	3.3	14.5
9	6.9	3.8	13.7
10	6.9	4.4	19.1
Average	6.4	4.2	16.4

^a Smallest.^b Largest.TABLE VII (k).—*Bast cells of Pipturus arborescens.*

Cell No.	Thick- ness of cell wall.	Diam- eter of lumen.	Total diam- eter of cells.
	μ	μ	μ
1	^a 9.9	17.5	42.0
2	^b 13.7	77.9	100.8
3	16.8	35.1	58.8
4	16.8	50.4	63.3
5	22.9	16.8	54.8
6	18.3	56.5	83.2
7	13.0	59.5	81.7
8	20.6	19.1	48.1
9	13.0	54.8	74.0
10	17.5	57.2	81.7
Average	16.2	44.5	68.8

^a Smallest.^b Largest.TABLE VII (i).—*Bast cells of Grewia multiflora.*

Cell No.	Thick- ness of cell wall.	Diam- eter of lumen.	Total diam- eter of cells.
	μ	μ	μ
1	^a 1.4	1.2	5.6
2	^b 9.8	3.0	20.3
3	7.6	3.0	15.3
4	6.9	4.0	18.3
5	6.6	1.8	13.7
6	6.1	3.8	15.0
7	5.2	2.3	11.4
8	6.9	3.0	16.8
9	7.6	5.2	18.3
10	2.6	1.8	9.9
Average	6.1	2.9	14.5

^a Smallest.^b Largest.TABLE VII (l).—*Bast cells of Sesbania grandiflora.*

Cell No.	Thick- ness of cell wall.	Diam- eter of lumen.	Total diam- eter of cells.
	μ	μ	μ
1	^a 2.3	1.4	8.4
2	^b 8.4	22.9	37.4
3	5.6	13.7	30.5
4	4.9	13.7	19.1
5	7.6	13.7	20.0
6	6.6	7.6	18.3
7	3.8	3.8	10.7
8	1.0	5.6	13.7
9	3.8	9.9	19.1
10	6.9	12.2	26.0
Average	5.0	10.4	20.3

^a Smallest.^b Largest.TABLE VII (j).—*Bast cells of Columbia serratifolia.*

Cell No.	Thick- ness of cell wall.	Diam- eter of lumen.	Total diam- eter of cells.
	μ	μ	μ
1	9.2	7.6	22.9
2	1.5	0.8	4.6
3	3.8	4.3	13.7
4	4.6	6.9	16.8
5	4.6	2.9	12.2
6	4.6	5.6	16.0
7	3.0	3.8	9.9
8	6.1	3.0	16.0
9	4.6	3.0	10.7
10	4.6	6.1	16.0
Average	4.8	4.4	13.9

TABLE VII (m).—*Bast cells of Wikstroemia ovata.*

Cell No.	Thick- ness of cell wall.	Diam- eter of lumen.	Total diam- eter of cells.
	μ	μ	μ
1	9.2	3.8	21.4
2	1.2	0.8	3.0
3	5.6	3.8	13.7
4	3.8	3.0	10.7
5	4.6	3.0	12.2
6	7.6	10.1	15.3
7	3.0	1.4	7.6
8	3.8	1.5	10.7
9	3.0	1.1	7.6
10	4.6	1.5	10.7
Average	4.6	2.2	11.3

TABLE VIII (a).—*Fibers of Abroma augusta.*

[Averages, 100 ultimates.]

No. of sample.	Nature of sample (plant 5½ m. high).	Length.	Longest diameter.
		mm.	mm.
1	Taken at ½ m. from base of the plant	2.419	0.017
2	Taken at 1 m. from base of the plant	2.753	.021
3	Taken at 2 m. from base of the plant	2.240	.014
4	Taken at 2½ m. from base of the plant	2.389	.016
5	Taken at 2¾ m. from base of the plant	1.961	.015
6	Taken at 3¼ m. from base of the plant	2.640	.025
7	Taken at 4¼ m. from base of the plant	2.430	.015
8	Taken from a twig 2 m. from top of tree	1.707	.014
9	Taken from a twig 2½ dm. long from main stem	1.774	.017
10	Taken from middle of a main branch, 1 dm. diameter	1.815	.014
	Grand average	2.213	.017

TABLE VIII (b).—*Fibers of Kleinhofia hospita.*

[Averages, 100 ultimates.]

No. of sample.	Nature of sample (tree 3.9 m. high).	Length.	Longest diameter.
		mm.	mm.
1	From main trunk at part 30 cm. above ground and 35.5 cm. circumference	1.212	0.014
2	From middle of a twig 2½ dm. long of a secondary branch, at ¾ cm. diameter	1.436	.015
3	From a primary branch borne 104 cm. above ground; sample at part of branch 6.8 cm. circumference and 7 cm. away from trunk	1.482	.015
4	Primary branch 117 cm. above ground; sample at part 7.4 cm. circumference and 10 cm. from main trunk	1.309	.015
5	Primary branch 117 cm. above ground, at part 2.4 cm. circumference and 46 cm. away from trunk	1.788	.012
6	From main trunk at part 25.5 cm. circumference and 150 cm. above ground	1.488	.014
7	From a branch borne 161 cm. above ground, 16.5 cm. circumference and 5 cm. away from trunk	1.356	.015
8	From main trunk at part 13 cm. circumference and 180 cm. above ground	1.598	.016
9	From main trunk at part 270 cm. above ground and 10.5 cm. circumference	1.783	.015
10	Taken near top of main branch, 330 cm. above ground, and 8 cm. circumference	1.424	.019
	Grand average	1.518	.015

TABLE VIII (c).—*Fibers of Melochia umbellata.*

[Averages, 100 ultimates.]

No. of sample.	Nature of sample.	Length.	Longest diameter.
		mm.	mm.
1	From main trunk 42 cm. above ground at 13.5 cm. diameter	2.540	0.019
2	From main trunk 125 cm. above ground at 11.5 cm. diameter	2.311	.019
3	From main trunk 163 cm. above ground at 14.5 cm. diameter	2.344	.015
4	From main trunk 218 cm. above ground at 12 cm. diameter	1.994	.018
5	From main trunk 252 cm. above ground at 10 cm. diameter	1.970	.015
6	From primary branch, 183 cm. above ground, 11 cm. away from trunk at 5.5 cm. diameter	1.903	.015
7	From primary branch (same as 6) 63 cm. away from trunk at 4.8 cm. diameter	2.040	.015
8	From secondary branch 5 m. above ground at part 10 cm. away from trunk at 1.5 cm. diameter	1.801	.017
9	From same branch as sample 8, but cut near tip at 0.9 cm. diameter	1.781	.015
10	From tertiary branch at 0.6 cm. diameter	1.765	.015
	Grand average	2.045	.016

TABLE VIII (d).—*Fibers of Urena lobata.*

[Averages, 100 ultimates.]

No. of sample.	Nature of sample (plant 2 m. high).	Length.	Longest diameter.
		mm.	mm.
1	From main stem at part 2.5 cm. above ground and 8 mm. diameter	1.309	0.012
2	From main stem at part 11.5 cm. above ground and 6 mm. diameter	1.527	.013
3	From main stem at part 9.5 cm. above ground and 10 mm. diameter	1.279	.012
4	From primary branch, 50 cm. above ground at part 2½ cm. away from main stem and 6 mm. diameter	1.381	.014
5	From main stem at part 19.5 cm. above ground and 8 mm. diameter	1.504	.016
6	From main stem at 16 cm. above ground and at 7 mm. diameter	1.541	.016
7	From main stem at 5 cm. above ground and at 9 mm. diameter	1.248	.013
8	From main stem at 25 cm. above ground and at 7 mm. diameter	1.511	.013
9	From primary branch 14½ cm. high on stem at 15 cm. away from it and at 6 mm. diameter	1.833	.014
10	From primary branch 15 cm. high on main stem at 3 cm. away from it and at 6 cm. diameter	1.284	.012
	Grand average	1.442	.013

TABLE VIII (e).—*Fibers of Hibiscus sabdariffa*.

[Averages, 100 ultimates.]

No. of sample.	Nature of sample (age of plant, 9 mo., 26 days).	Length.	Longest diameter.
		mm.	mm.
1	At base of main stem and at part 7.5 cm. circumference.....	1.859	0.015
2	From a primary branch borne 2.5 cm. above ground at part 3.2 cm. circumference and 1.5 cm. away from main stem.....	1.542	.019
3	From some primary branch, but at part 2.5 cm. circumference.....	1.725	.021
4	From main stem at height 9 cm. and at part 6.1 cm. circumference.....	2.324	.021
5	From a primary branch 15 cm. above ground at 2.5 cm. circumference and 55.3 cm. away from main stem.....	2.045	.022
6	From main stem 33 cm. above ground at 4.7 cm. circumference.....	1.916	.021
7	From main stem 73.5 cm. above ground at 4.1 cm. circumference.....	2.235	.021
8	From main stem 114 cm. above ground at 3.4 cm. circumference.....	1.987	.023
9	From main stem 166 cm. above ground at 2.4 cm. circumference.....	1.853	.018
10	From main stem 210.3 cm. above ground at 1.6 circumference 24.5 cm. from apex.....	1.840	.017
	Grand average.....	1.928	.020

TABLE VIII (f).—*Fibers of Malachra fasciata*.

[Averages, 100 ultimates.]

No. of sample.	Nature of sample.	Length.	Longest diameter.
		mm.	mm.
1	From a flowering plant, 11.5 cm. above ground at 1.2 cm. diameter.....	1.831	0.017
2	From a flowering plant, 51 cm. above ground at 1 cm. diameter.....	1.821	.016
3	From a flowering plant, 75 cm. above ground at 9 cm. diameter.....	2.611	.018
4	From a flowering plant, 83 cm. above ground at 0.3 cm. diameter.....	1.820	.019
5	From a flowering plant, cut near tip, at 5 cm. diameter.....	2.163	.017
6	From a fruiting plant, 30 cm. above ground at 1.4 cm. diameter.....	1.954	.016
7	From a fruiting plant, 100 cm. above ground at 1.3 cm diameter.....	1.984	.015
8	From a fruiting plant, 60 cm. above ground at 1.4 cm. diameter.....	2.190	.016
9	From a fruiting plant, 97 cm. above ground at 1.2 cm. diameter.....	2.014	.016
10	From near tip, at 0.9 cm. diameter.....	1.754	.015
	Grand average.....	2.014	.016

TABLE VIII (g).—*Fibers of Malachra capitata*.

[Averages, 100 ultimates.]

No. of sample.	Nature of sample (plant 64 cm. high; age, 10 mo., 3 da.).	Length.	Longest diameter.
		mm.	mm.
1	At 40 cm. from base at 7 mm. diameter.....	2.592	0.015
2	At 17 cm. from base at 6.5 mm. diameter.....	3.616	.015
3	At 23 cm. from base at 5.5 mm. diameter.....	2.091	.017
4	At 33 cm. from base at 6 mm. diameter.....	4.041	.014
5	At base of stem, at 9 mm. diameter.....	2.345	.018
6	At 48 cm. from base at 6 mm. diameter.....	2.036	.013
7	At 51 cm. from base at 5.5 mm. diameter.....	3.041	.015
8	At 54 cm. from base at 5.5 mm. diameter.....	2.907	.013
9	At 62 cm. from base at 5.4 mm. diameter.....	2.776	.014
10	At 3 cm. from base at 12 mm. diameter.....	2.136	.014
	Grand average.....	2.788	.015

TABLE VIII (h).—*Fibers of Triumfetta bartramia*.

[Averages, 100 ultimates.]

No. of sample.	Nature of sample.	Length.	Longest diameter.
		mm.	mm.
1	From main stem 4 cm. high from base at 1.5 cm. diameter.....	2.023	0.017
2	From main stem 30.8 cm. high from base at 1.5 cm. diameter.....	1.675	.015
3	From main stem 18.9 cm. high from base at 1.5 cm. diameter.....	1.895	.016
4	From main stem 50 cm. high from base at 1.0 cm. diameter.....	1.741	.016
5	From a primary branch at part 5 mm. diameter.....	2.088	.014
6	From a primary branch near tip.....	2.333	.016
7	From a branch 2 dm. long at part 2 mm. diameter.....	2.319	.017
8	From main stem, $\frac{1}{2}$ cm. diameter.....	2.073	.016
9	From middle of main stem, 4 mm. diameter.....	1.978	.017
10	From main stem, at part 5 mm. diameter.....	1.144	.018
	Grand average.....	2.027	.016

NOTE.—The three plants from which samples 1 to 6, inclusive, were taken were all uniformly 2.25 meters high and all were beginning to fruit. That used in samples 7 to 10 was 70 centimeters high and also beginning to fruit.

TABLE VIII (i).—*Fibers of Grewia multiflora.*

[Averages, 100 ultimates.]

No. of sample.	Nature of sample.	Length.		Longest diameter.
		mm.	mm.	
1	From main trunk 30 cm. above ground and 14 cm. circumference.....	2.070	0.016	
2	From main trunk 60 cm. above ground and 12.5 cm. circumference.....	1.931	.016	
3	Main trunk 90 cm. above ground and 11.9 cm. circumference.....	2.229	.016	
4	From main trunk 120 cm. above ground and 11.8 cm. circumference.....	2.032	.015	
5	From main trunk 140 cm. above ground and 11.7 cm. circumference.....	1.621	.017	
6	From primary branch 6 cm. away from trunk, at part 5.5 cm. circumference.....	1.620	.015	
7	From secondary branch 7 cm. away from primary branch part 3.1 cm. circumference.....	1.669	.015	
8	From main trunk 195 cm. above ground.....	1.926	.014	
9	From primary branch 8 cm. away from trunk, at 3.7 cm. circumference.....	1.771	.015	
10	From tertiary branch 2.5 cm. away from trunk at 1.5 cm. circumference.....	1.560	.014	
	Grand average.....	1.843	.015	

TABLE VIII (j).—*Fibers of Columbia serratifolia.*

[Averages, 100 ultimates.]

No. of sample.	Nature of sample.	Length.		Longest diameter.
		mm.	mm.	
1	From main stem, 17 cm. above ground at 8.5 cm. diameter.....	1.643	0.012	
2	From main trunk 51 cm. above ground at 8 cm. diameter.....	1.696	.014	
3	From primary branch 5.6 cm. above ground at part 6 mm. diameter.....	1.437	.015	
4	From main trunk 113 cm. above ground at 7.4 cm. diameter.....	1.680	.018	
5	From main trunk 163 cm. above ground at 6.9 cm. diameter.....	1.868	.013	
6	From main trunk 215 cm. above ground at 5.8 cm. diameter.....	1.828	.013	
7	From primary branch, 217 cm. above ground at 1.6 cm. diameter.....	1.372	.015	
8	From same as 7, at part 1.1 cm. diameter.....	1.585	.015	
9	From secondary branch, from which No. 7 was taken, at 9 mm. diameter.....	1.357	.014	
10	From tertiary branch of branch from which No. 7 was taken, at 4 mm. diameter.....	1.462	.014	
	Grand average.....	1.593	.014	

TABLE VIII (k).—*Fibers of Pipturus arborescens.*

[Averages, 100 ultimates.]

No. of sample.	Nature of sample (plant 5 m. high, beginning to flower).	Length.		Longest diameter.
		mm.	mm.	
1	From main trunk, at 8 cm. above ground and at 20.4 cm. circumference.....	4.696	0.022	
2	From main trunk, at 32 cm. above ground and at 18.6 cm. circumference.....	5.116	.024	
3	From main trunk, at 60 cm. above ground and at 18.8 cm. circumference.....	4.983	.021	
4	From main trunk, at 95.5 cm. above ground and at 18.9 cm. circumference.....	4.853	.024	
5	From primary branch 134 cm. above ground, at part 4 cm. away from trunk and at 2.5 cm. circumference.....	5.183	.020	
6	From main trunk 162 cm. above ground, at 16.8 cm. circumference.....	5.221	.023	
7	From main trunk 184 cm. above ground, at 15 cm. circumference.....	4.813	.024	
8	From primary branch 210 cm. above ground, at part 2 cm. away from trunk and at 4.9 cm. circumference.....	5.181	.020	
9	From main trunk 98 cm. above ground, at 18.2 cm. circumference.....	5.259	.020	
10	From secondary branch, at 2.4 cm. circumference.....	5.238	.022	
	Grand average.....	5.054	.022	

TABLE VIII (l).—*Fibers of Sesbania grandiflora.*

[Averages, 100 ultimates.]

No. of sample.	Nature of sample (height of plant, 5 m.).	Length.		Longest diameter.
		mm.	mm.	
4	From main stem, 161 cm. above ground at part 13 cm. circumference.....	2.299	0.019	
6	From main stem, 150 cm. above ground at part 11 cm. circumference.....	3.213	.024	
9	From main stem, 174 cm. above ground and at part 13 cm. in circumference.....	2.960	.026	
10	From main stem, 245 cm. above ground at part 11.4 cm. circumference.....	2.475	.020	
	Grand average.....	2.737	.023	

NOTE.—No whole fibers could be obtained by maceration from samples 1, 2, 3, 5, 7, and 8.

TABLE VIII (m).—*Fibers of Wikstroemia ovata.*

[Averages, 100 ultimates.]

No. of sample.	Nature of sample.	Length.	Longest diameter.
		mm.	mm.
1	From main stem, 5 cm. above ground, at 2.4 cm. diameter	2.747	0.013
2	From main stem, 35.1 cm. above ground, at 2 cm. diameter	3.451	.010
3	From a primary branch, 19.5 cm. from main stem and at 1.3 cm. diameter	3.041	.011
4	From a secondary branch, 1.5 cm. away from primary, and at 6 mm. diameter	2.836	.011
5	From a primary branch, 37 cm. away from main stem, at 1 cm. diameter	3.863	.012
6	From a tertiary branch, 1 cm. from secondary, at 6 mm. diameter	2.852	.013
7	From a tertiary branch, 13 cm. away from secondary, at 6 mm. diameter	3.032	.012
8	From a tertiary branch, 38 cm. away from secondary, at 5 mm. diameter	2.409	.012
9	From a small twig, at 3 mm. diameter	2.419	.012
10	From a small twig, at 4 mm. diameter	2.419	.012
	Grand average	2.972	.012

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EXPLANATION OF PLATES.

Plates I–IV show drawings of cross sections of bast and surrounding cells and of longitudinal view of portions of ultimate fibers.

Plate I; fig. 1, *Abroma augusta*; fig. 2, *Kleinhofia hospita*; fig. 3, *Melochia umbellata*.

Plate II; fig. 1, *Urena lobata*; fig. 2, *Hibiscus sabdariffa*; fig. 3, *Malachra fasciata*.

Plate III; 1, *Malachra capitata*; fig. 2, *Triumfeta bartramia*; fig. 3, *Grewia multiflora*.

Plate IV; fig. 1, *Columbia serratifolia*; fig. 2, *Pipturus arborescens*; fig. 3, *Wikstroemia ovata*.

REFERENCES ON PLATES.

o=parenchyma cell.
z=intercellular space.
l=lumen of bast cell.
bl=broad lumen.
nl=narrow lumen.
a=cell without lumen.
cw=cell wall.
d=diagonal thickening of cell wall.
f=cross folds.
rd=ridge.

g=stratified layer.
x=dislocations.
v=pit.
e=typical apex.
w=blunt apex.
c=branch.
y=bifurcation.
p=middle piece of ultimate fiber.
k=broken places of ultimate fibers.

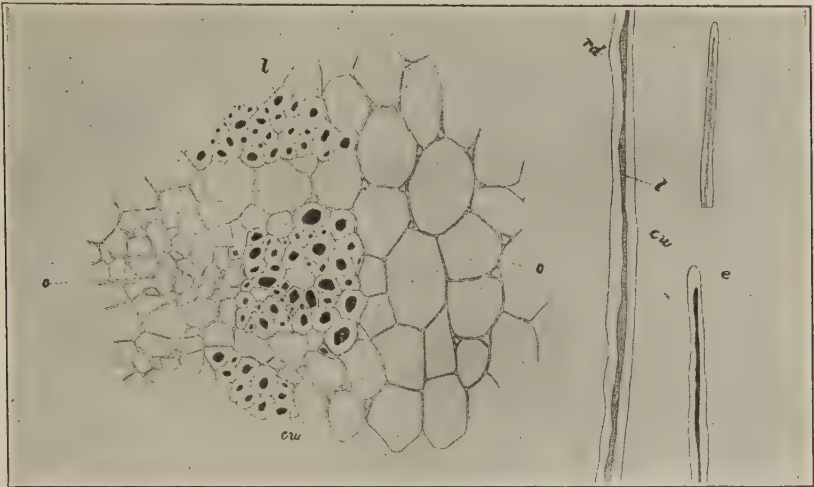


FIG. 1. *Abroma augusta*. (X 350.)

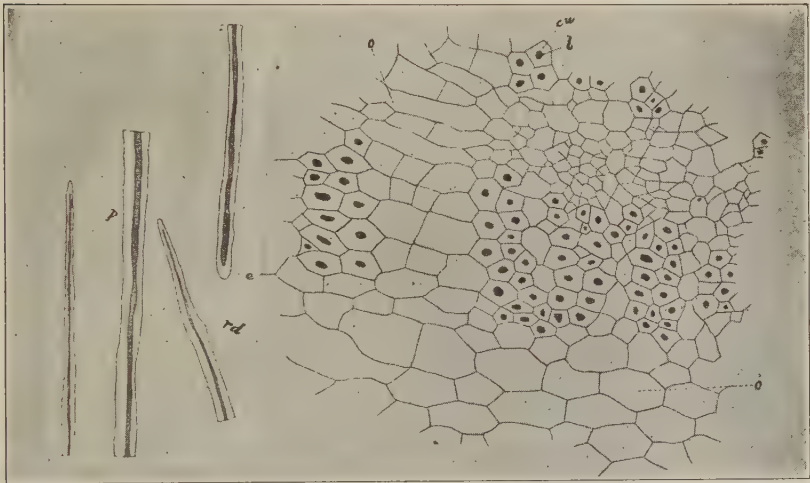


FIG. 2. *Kleinhofia hospita*. (X 302.)

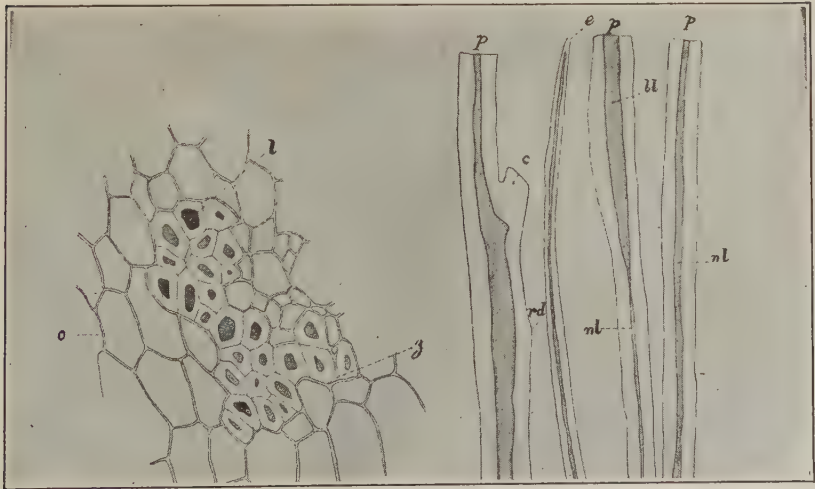


FIG. 3. *Melochia umbellata*. (X 368.)

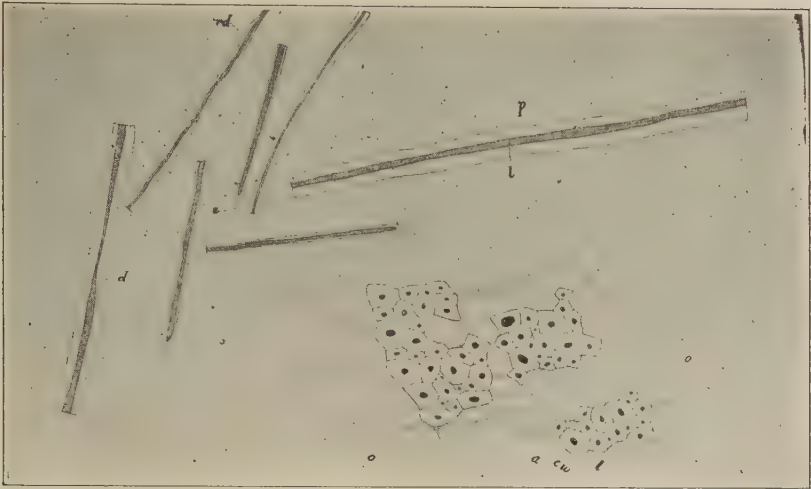


FIG. 1. *Urena lobata*. (× 299.)



FIG. 2. *Hibiscus sabdariffa*. (× 342.)

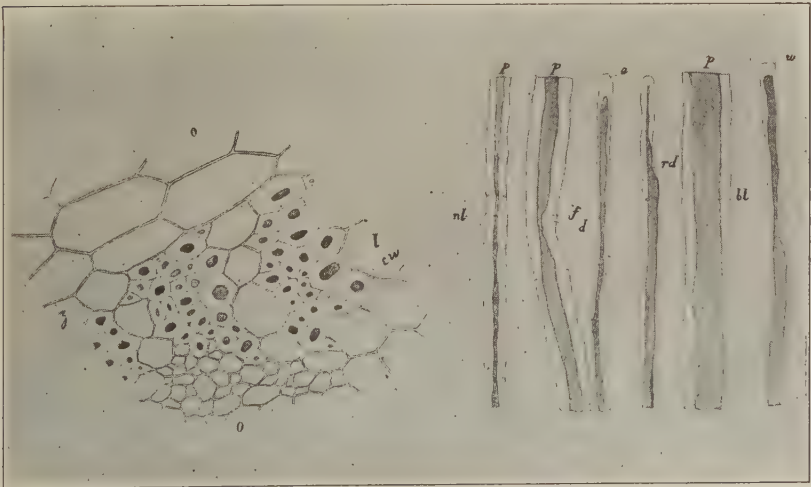


FIG. 3. *Malachra fasciata*. (× 284.)

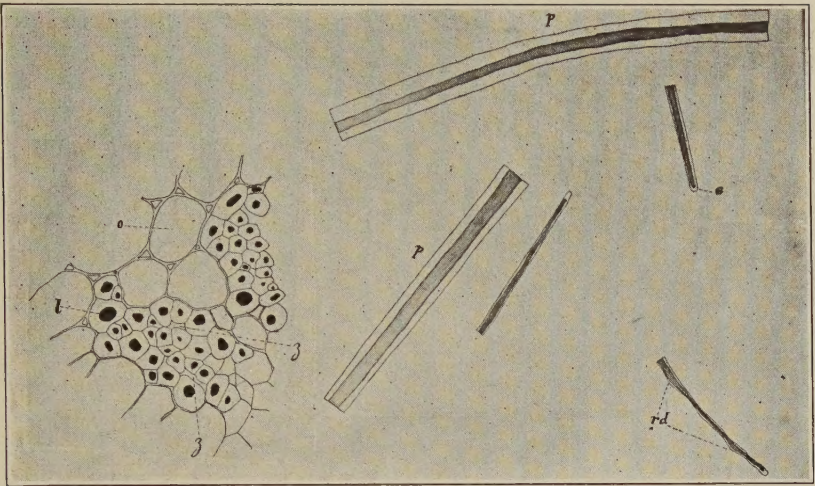


FIG. 1. *Malachra capitata*. ($\times 314$.)

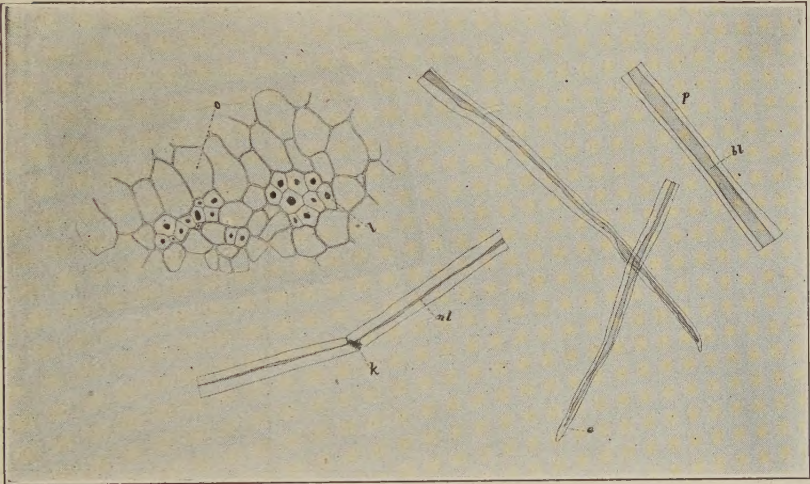


FIG. 2. *Triumfetta bartramia*. ($\times 283$.)

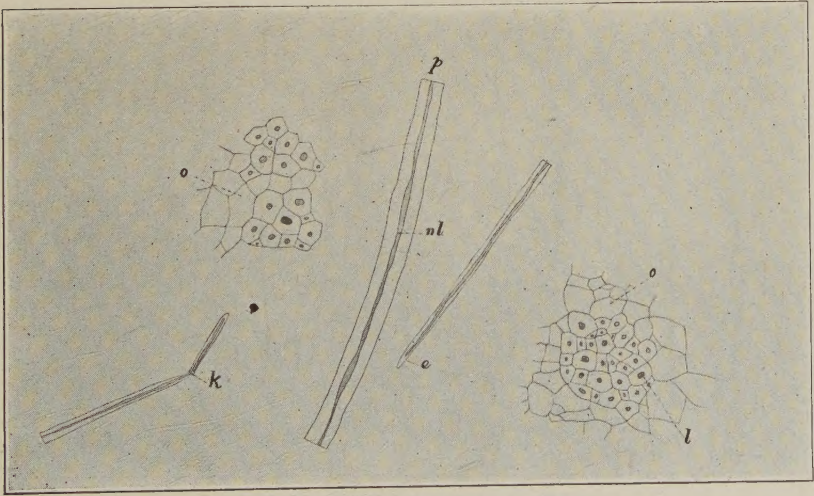


FIG. 3. *Grewia multiflora*. ($\times 367$.)

COLLEGE NOTES.

Dr. Manuel L. Roxas has been appointed secretary to the acting dean.

President Villamor of the University is acting dean of this college until Dr. Copeland's successor is appointed.

Mr. Elias H. Pañganiban, '15, was recently appointed assistant in agronomy in this college.

Mr. Elias Manalang, formerly clerk of the property and disbursing office of this college, was promoted to the rank of property officer to succeed Mr. Davis.

Samuel F. Trelease, Ph. D., Johns Hopkins University, was appointed assistant professor of plant physiology in this college and has reported for duty on August 27.

A mess hall for the students of the College of Agriculture was opened under the management of Dr. Manuel L. Roxas. It is serving meals to students at a reasonably moderate cost.

Professor Edwin Bingham Copeland, founder and first dean of the College of Agriculture, retired under the Osmeña Act. He sailed with his family for the homeland on August 31.

Mr. Gerardo O. Ocfemia, on nomination by the dean's office, has been elected by the executive committee of the student body to the post of assistant editor of the AGRICULTURIST, relieving Mr. Aldaba.

Mr. Amos A. Davis, until recently instructor in German and property officer, and Mrs. Anna L. Davis, formerly instructor in mathematics, both of this college, retired under the Osmeña Act. They sailed for the homeland last summer.

Mr. Rafael B. Espino, a 1915 graduate of this college and for some time assistant in botany, has been awarded an University fellowship. He is now taking postgraduate course in plant anatomy in the University of Chicago.

The afternoon of August 29 was set aside as a field day, on which track and other athletic events were held. A special feature of the day was a bicycle ring race, with appropriate prizes offered by Dr. Villacorta.

The College of Agriculture has recently purchased eight head of carabao, the number increasing to ten inside of two months. This is the first time since the foundation of this college that it enjoys the possession of any carabao.

Mr. Vicente C. Aldaba resigned from his position at the College of Agriculture to enter private life as a farmer in Mindanao. With the resignation of Mr. Aldaba, THE PHILIPPINE AGRICULTURIST AND FORESTER loses an useful member of its editorial staff.

Steps have been taken to secure the services of Professor Charles Fuller Baker as dean of the College of Agriculture to succeed Professor Copeland. Professor Baker's appointment would meet with the unanimous approval of both the faculty and the student body of this college.

Although rinderpest has been playing havoc on the work animals at Los Baños and vicinity, not a single case has appeared in this college. Here is a practical object lesson in the way of showing what scientific management will do when applied to farm operations.

Vice-Governor Yeater, accompanied by President Villamor, visited the College of Agriculture on the 14th of this month. After inspecting the various departments of the college, he met the faculty and the students in a body, and made a stirring talk, partly dwelling on his very favorable impression of the work of this institution.

An orchestra composed of members of the student bodies of the College of Agriculture and the School of Forestry was recently organized with Mr. Dionisio Aquino as conductor. The funds for this purpose were raised mainly by subscription from members of the 1916 Farmers' Congress who visited the college last year.

Professor Charles Fuller Baker, chief of the department of agronomy of college, was granted a year's leave of absence, beginning the first of May of this year. His present address is Botanic Gardens, Singapore, where he is for the time being assistant director, in charge of tropical plantings.

Mr. Arsenio M. Bayla, in connection with his thesis work at this college, succeeded in producing eggplant crosses between the large, round New York improved and the long native varieties. The new type is intermediate in size between the parents and combines many of the good qualities of the two. A detailed report of the results will be published later in this paper.

The alumni of the College of Agriculture, jointly with the members of the faculty and other friends, gave a banquet at the Manila Hotel in honor of Professor Copeland. A similar friendly demonstration on the part of the president and the deans of various colleges of the University took the form of an informal despedida on August 25 in the University Hall.

A letter received from Washington, D. C., advises Mr. Mariano G. Medalla, '17, of his appointment by the United States Department of Agriculture to the post of assistant in citriculture, with station at this college. Mr. Medalla enjoys the unique distinction of being the first Filipino graduate of the College of Agriculture to be employed by the Federal Government.

The following promotions in the teaching staff of the College of Agriculture took effect July 1: Manuel L. Roxas, from instructor to assistant professor of chemistry; Bienvenido M. Gonzalez, from instructor to assistant professor of animal husbandry; Inocencio Elayda, from instructor to assistant professor of agronomy; Jose J. Mirasol, from assistant to instructor in agronomy.

A farewell reception to Dr. and Mrs. Copeland was given by the student body of the College of Agriculture in the college auditorium at 8 o'clock in the evening, August 29. The main features of the evening were the unveiling of an oil portrait of Dr. Copeland, which the student body acquired for hanging in the office of the dean, and the presentation to the guests of honor by the members of the faculty of the College of Agriculture and the School of Forestry of a set of silverware.

As a result of the last two elections, the officers of the student body for the present semester are: Faustino Q. Otones, president; Herbert Copeland, vice-president, resigned, and succeeded by German Yap; Eligio C. Cruz, secretary; Gerardo O. Oc-femia, treasurer; Eduardo Quisumbing, athletic representative; Francisco O. Santos, college editor; and Mariano B. Ray-mundo, manager, for *The 1918 Philippinensian*; José Q. Dacanay, editor, and Leopoldo B. Uichanco, manager, for the *Varsity News*.

The College Coöperative Co., Inc., opened in October of last year with Professor Gonzales as director, gives every promise of being a big business success. After deducting the considerable initial expenses of propaganda, organization, incorporation, etc., it was able to distribute a bonus of 13 per cent on the purchases of its stockholders at the end of three months' operation. We are glad to hear that our colleagues of the University in Manila are emulating our example by starting a similar organization in the city. We wish them good luck and all the success that we are having, in their new enterprise.